THE EXPLOSIVES ENGINEER

FORE-RUNNER OF PROGRESS IN
MINING-QUARRYING & CONSTRUCTION

NOVEMBER-DECEMBER • 1959

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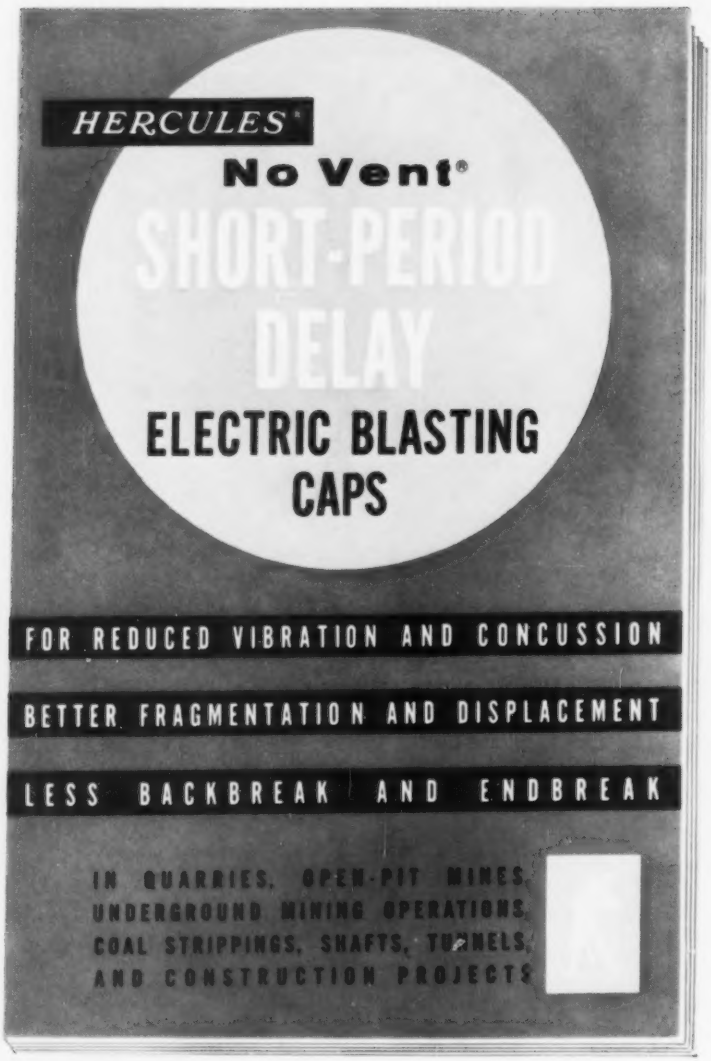
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THE EXPLOSIVES ENGINEER

Forerunner of Progress in Mining, Quarrying, Construction

The Loweville, or Valentine, bed of limestone found in the Bellefonte, Pennsylvania, area rates extremely high in quality. It has an average thickness of 70 ft. and dips from 75° to 90°.

The National Gypsum Company's operations, which take place on the north side of the valley in the steep-dip portion of the bed, first started as a surface quarry. Some years ago the operations were forced underground because of the increasing depth of the limestone.

E. L. Kreider's article, "Mining Limestone in a Deep Pennsylvania Mine," starting on page 167 describes the geological formations and traces the development of this property from a surface to an underground operation, and outlines some of the methods used in this transition.

° ° °

Recently there has been a marked trend to underground caverns for the storage of LP gas rather than the conventional above-ground tank-storage method.

Besides the safety factor involved there is also a decided financial advantage to this new method. It has been estimated that underground storage costs run approximately $4 to $6 per barrel compared with the $25 per barrel cost for surface storage. Quite a saving.

Fenix & Scisson, Inc., underground-storage-cavern specialists of Tulsa, Oklahoma, is now engaged in "Operation Todhunter," a large-scale mining project which will provide several of these caverns for the storage of LP gas in the vicinity of Middletown, Ohio.

R. L. Rough of Pittsburgh, who has had extensive contacts with "Operation Todhunter," writes an unusually interesting article on this operation. We are fortunate, also, in being able to use some excellent underground photographs, courtesy of Texas Eastern Transmission Corporation, to illustrate this article beginning on page 175.

° ° °

Upon completion, the Mammoth Pool Hydroelectric Project will add 126,000 kw. to Southern California Edison's generating facilities at Big Creek. This will make a total of 666,000 kw. available from this system to meet the needs of power-hungry industrial Southern California.

The project consists of the Mammoth Pool Dam, which will create a reservoir of 123,000 acre-feet; an 8-mile 20-ft.-diameter power tunnel; and a two-unit powerhouse as well as other necessary structures. The article, outlining the highlights of the project and many of the important construction procedures, starts on page 182. It is interestingly and factually written by Neville S. Long, resident engineer for the project.

° ° °

One never knows just what job dynamite will next be called upon to do.

Down on Maryland's Eastern Shore a contractor recently ran into difficulties that responded to dynamite's gentle nudging. He was erecting a barrack-type building in which the jack-slab method was being used. With this method the floor slab is poured, and a separation compound is then spread over this before the pouring of the roof slab. Upon hardening, the roof slab is jacked into position and bolted. Imagine the contractor's surprise when he discovered that the separation compound did not work, and the floor slab had been raised with the roof.

The problem was how to separate the slabs without damage to the roof. Normal methods failing, the contractor resorted to blasting. Tests proved that 1-oz. charges of 40% gelatin were just right.

For a brief account of this problem and its solution, please turn to page 186 and read the short article by William F. Hallstead.

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Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

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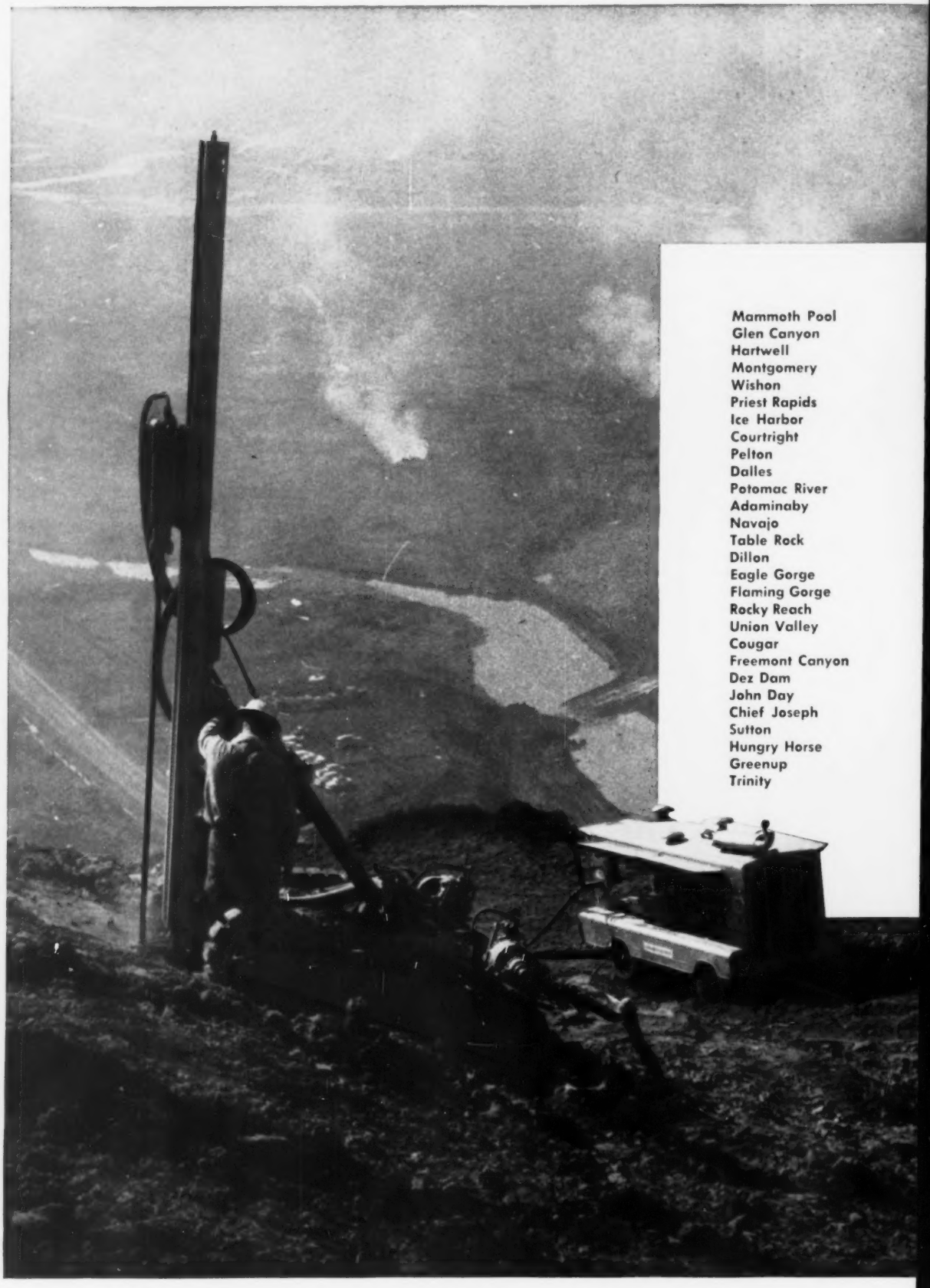

Mammoth Pool
Glen Canyon
Hartwell
Montgomery
Wishon
Priest Rapids
Ice Harbor
Courtright
Pelton
Dalles
Potomac River
Adaminaby
Navajo
Table Rock
Dillon
Eagle Gorge
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Frank Coolbaugh

PRESIDENT

CLIMAX MOLYBDENUM COMPANY

A Biography

FRANK COOLBAUGH, a miner from a mining family, has worked his way up from mine helper to head the world's largest and leading molybdenum company. Born in Rapid City, South Dakota, the son of M. F. and Osie (Smith) Coolbaugh, Frank was surrounded with mining at the age of seventeen when his father became president of the Colorado School of Mines. It was thus logical that the men of the family should be schooled there, and he, his two brothers, and his son became graduates of the Colorado School of Mines.

Frank began his mining career with the U. S. Fuel Company, working two years as a coal miner at Mohrland, Utah. In 1933 he joined Climax, and has remained in its employ ever since. One of his first jobs was participating in what was then the biggest underground blast on record, which initiated the caving system on the Phillipson level at Climax. This blast consumed 110,500 pounds of dynamite, and was detonated with 6,350 electric blasting caps. The shot also marked the beginning of large-scale production of ore at Climax, for the engineers calculated the big blast broke 350,000 tons of ore and made another 500,000 tons available as a result of the caving.

At the time of this blast Frank was a mine helper, but he worked through many of the operating jobs in the mine and concentrator before becoming assistant mill superintendent. Subsequently, he became, successively, assistant mine superintendent, planning director, assistant general superintendent, general superintendent, resident manager, general manager, vice president in 1954, and director in 1955. He assumed his present post of president on June 1, 1959. Climax is now a division of American Metal Climax, Inc., since its merger with the American Metal Company in January, 1958. Frank is a vice president and director of the parent firm.

In World War II he served with the Army Engineers in Alaska and the Aleutians, which made him keenly aware of the vast distances in what is now our largest state, and also aware that climatic variations there are quite foreign to the thinking of most Americans. Except for three months at the Field Officers School at Fort Belvoir, Virginia, in 1944, Frank spent the whole war working out of three locations in Alaska—Adak in the Aleutians, Excursion Inlet in southeast Alaska, and on the Yukon River at Galena.

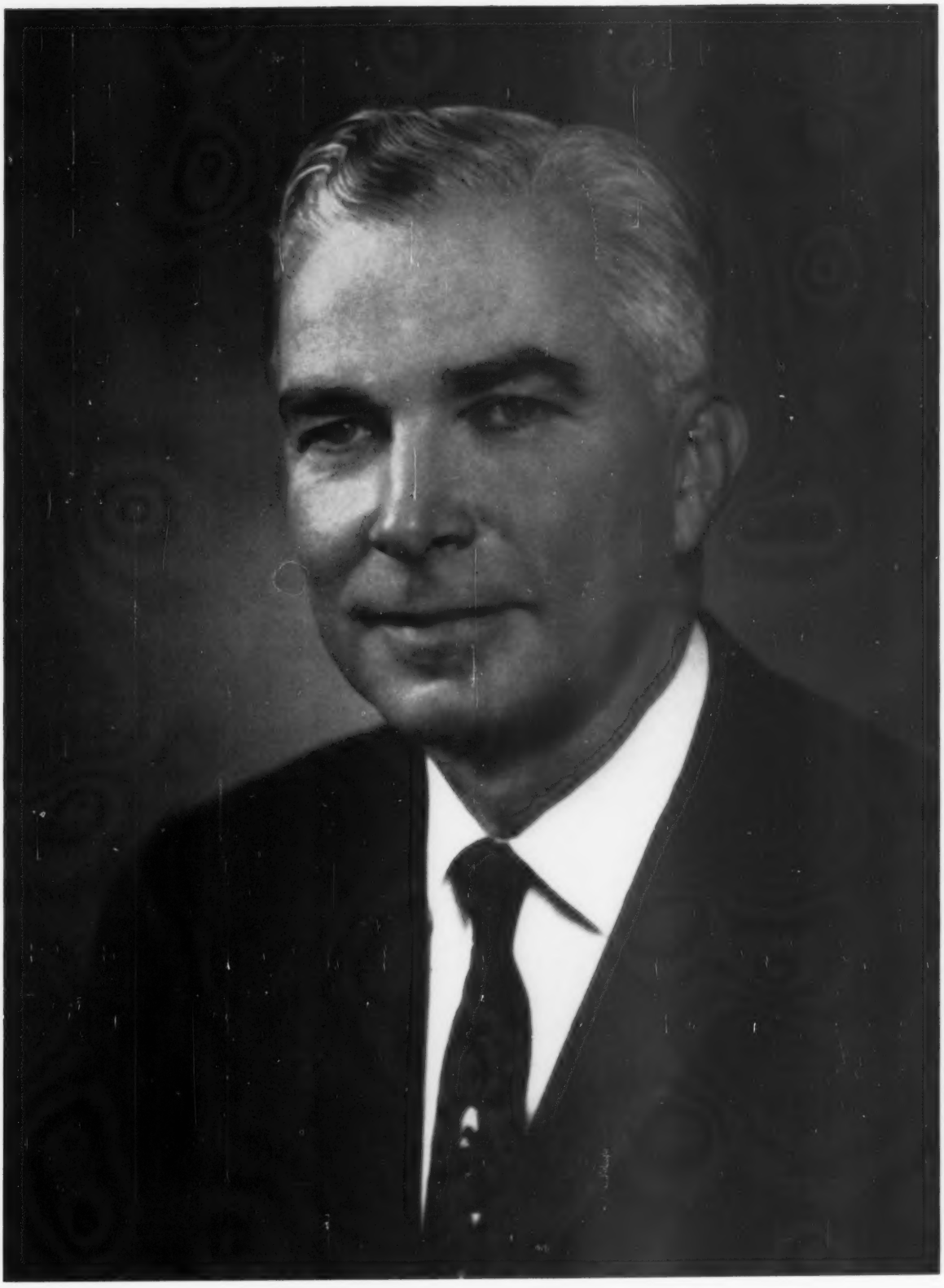
He was station engineer in charge of construction and engineering work at Galena, where the Army was building an intermediate airport for planes being ferried to the Russians. At Fairbanks we delivered planes to the Russians, who flew them to an airfield west of Nome before taking off for Russia. This jump was 600 miles long, so that an intermediate station for fuel and supplies was needed at Galena, located approximately 700 miles up the Yukon from its mouth.

In the Aleutians the job undertaken was the construction of air bases, docks, sea walls, harbor, housing, and warehouse facilities. The job at Adak, while not large in comparison with some of the Army construction jobs on foreign soil, was the largest attempted anywhere until that time on American soil. Frank was operations officer here, with much of the work contracted to American construction firms.

Along with his job of president of Climax Molybdenum, Frank is also president of the Climax Uranium Company and holds down a host of jobs as president and director of other Climax subsidiaries. He is also a director of the Colorado School of Mines Research Foundation, the Colorado National Bank, and, until he moved East, was a director of the Colorado Chamber of Commerce and the Mountain States Employers Council.

He is a member of the Western Governors' Mineral Advisory Council, and chairman of the Materials Advisory Board Panel on Molybdenum, National Academy of Science, Materials Advisory Board Committee on Refractory Metals. He is a member of the American Institute of Mining and Metallurgical Engineers, a councilman of the Mining and Metallurgical Society of America, and a member of the Colorado Mining Association.

Since moving East he has made his home, temporarily at least, in Greenwich, Connecticut.



FRANK COOLBAUGH

Editorial

Incentive Makes the Difference

A little item buried in the back pages of the business section of a daily paper recently was devoted to the report of the Atomic Energy Commission's release of statistics on domestic uranium production and ore reserves in the years 1948-1959. The newspaper item was correctly headlined "Uranium Output Soars." The headline might have said "Output Skyrocketed," for the commission reported output of ore was 54,000 tons in 1948 and more than 6,000,000 tons in 1959.

Domestic ore reserves of uranium shot up almost as much – from 1,000,000 tons in 1948 to 88,900,000 tons in 1959. This fabulous increase of 111 times for ore production and 89 times for ore reserves should be taken as a tribute to the American mining industry, which rose to a national emergency and found uranium ore at a time when it was widely held that the U. S. was in dire need of uranium and without the domestic resources to meet that need. And the industry not only got out and prospected for ore, but also speeded up to more than adequate production in very short order.

Besides the diligence and energy of American men and management in mining, one further element in the achievement should not be overlooked. The Government, in the emergency, set a domestic price high enough to make it worthwhile to prospect for the ore and turn out the production. It has been said by some that the price set was too high, and that the Government wasted the taxpayers' money in a needless subsidy to the mining industry. Whether or not this is true, the fact remains that the price set persuaded miners and prospectors to embark immediately on financially risky ventures in the face of great odds and to bring forth the desired metal to meet the nation's need.

For such a strategically important ore the price paid does not seem excessive from the taxpayers' standpoint. The average price paid for ore over the 12-year period was $10.14 per pound, or a total of $888 million for the procurement of uranium concentrate (U_3O_8); these figures include purchases from private producers, cost of operating the AEC-owned mill at Monticello, Utah, and of weighing, sampling, and assaying, but exclude depreciation on AEC-owned facilities, bonus payments for initial ore production, and vanadium purchases.

The point to be taken from these recently issued statistics is that when the Government wants production of ores on which the price is fixed, it can usually get it by setting a realistic price which will provide some incentive to the mining industry. We are not in favor of lush subsidies, nor do we feel that the best interests of the nation are served when the price for a metal, such as silver, is set so far below the world price for the metal that silver consumers are benefited at the expense of the silver producers.

Explosives Engineer Award

Beginning with the contest year 1959 the basis of THE EXPLOSIVES ENGINEER award to the National Crushed Stone Association quarries will be changed. On the new basis the bronze plaque will be presented to the plant of the member of the National Crushed Stone Association which operated the greatest number of consecutive days without a disabling work injury. Heretofore the award has been made to the member quarry having the best record in the National Safety Competition.

The new criterion of the award will be more fitting in view of the division of the National Crushed Stone Association safety contest into five man-hour groups and the presentation of an award for outstanding safety performance to the quarry with the highest standing in each group.

The Accident Prevention Committee of the National Crushed Stone Association has approved the new standard for THE EXPLOSIVES ENGINEER award. The bronze plaque will be presented to the plant which, at the close of the contest year, has been operated the greatest number of consecutive days since its last disabling work injury, and which has throughout this period complied with the rules of the association contest.

THE EXPLOSIVES ENGINEER award will be presented each year at the annual convention of the association. At the next annual meeting, February 22-24, 1960, THE EXPLOSIVES ENGINEER award will be made for the contest year 1958 on the former basis.

The publishers of THE EXPLOSIVES ENGINEER and the Accident Prevention Committee feel that an award to the plant with the longest continuous run of accident-free days would do much to stimulate safety. The new plaque, to be presented a year later, will be on display at the 1960 meeting for members of the association to see.

Mining Limestone In A Deep Pennsylvania Mine

National Gypsum Company established a notable safety record with modern methods in its Bellefonte Mine

E. L. KREIDER°

NATIONAL GYPSUM COMPANY's Bellefonte Mine is located in Centre County, Pennsylvania, on the geographical center line of the State, near the town of Bellefonte. Agriculture, manufacturing, and the production of limestone and limestone products are the principal occupations of the area, with the last mentioned making an important contribution to the economic welfare of the community.

This is a direct result of the existence of a bed of limestone known as the Loweville, or Valentine, bed. Although it has been recognized in adjoining areas, it presents its best phase in the Bellefonte vicinity where the thickness averages 70 ft. of high-quality limestone, in fact, one of the two highest

°Hercules Powder Company
Pittsburgh, Pennsylvania

DRILLING: Drilling in a face at the Bellefonte, Pennsylvania, limestone mine of the National Gypsum Company.

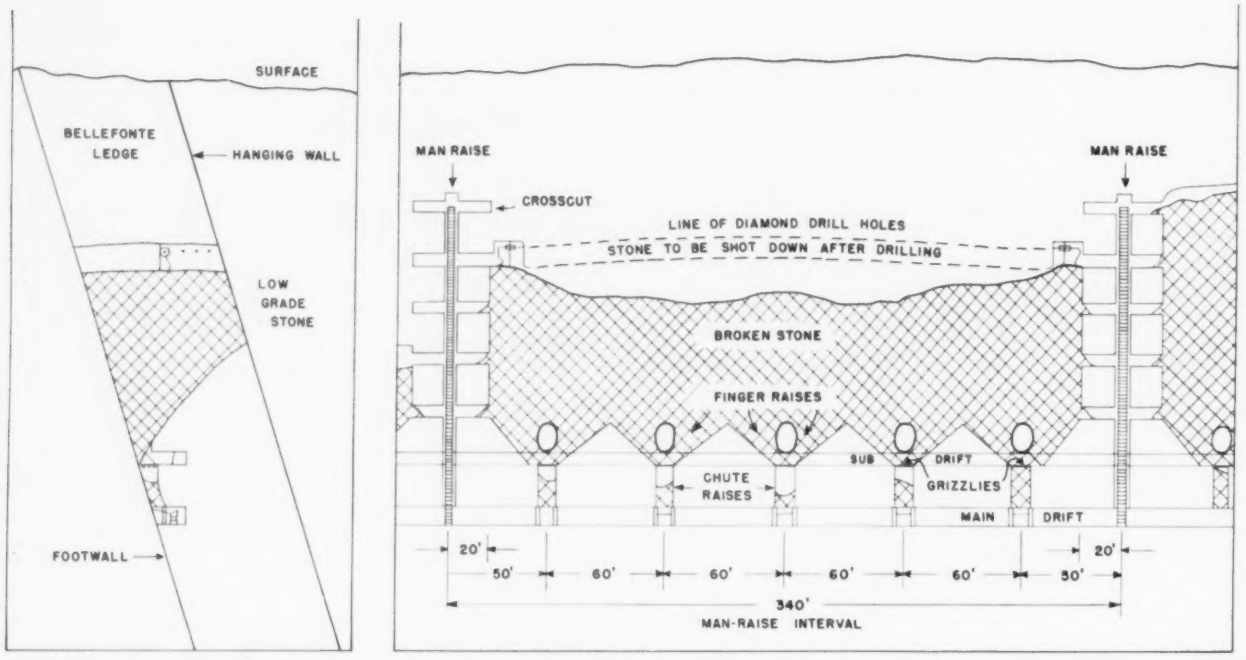


FIGURE 1: The shrinkage stope method of mining was used on the first level. It consisted of stopes 300 ft. in length with 40-ft. pillars between stopes. Sufficient pillars were maintained to prevent caving.

quality limestones in the United States.

The pure stone is encased in lower purity limestones on both sides and the top. Underlying this bed is high-quality limestone with greater silica content.

Geological Formation

During the geological formation of the limestone the beds were a syncline with N.E. and S.W. axis. The top eroded, resulting in two parallel seams 4 miles apart. On the north side of the valley, close to Bellefonte, the dips are steep, ranging from 75° to 90° N.W. whereas on the south side the dips range from 20° to 30° S.E. The National Gypsum operation is in the northerly and steep-dip portion of the bed.

During the early days of the limestone development in this area the operations consisted of surface quarrying. This mine started as a surface operation under the management of the Chemical Lime Company and con-

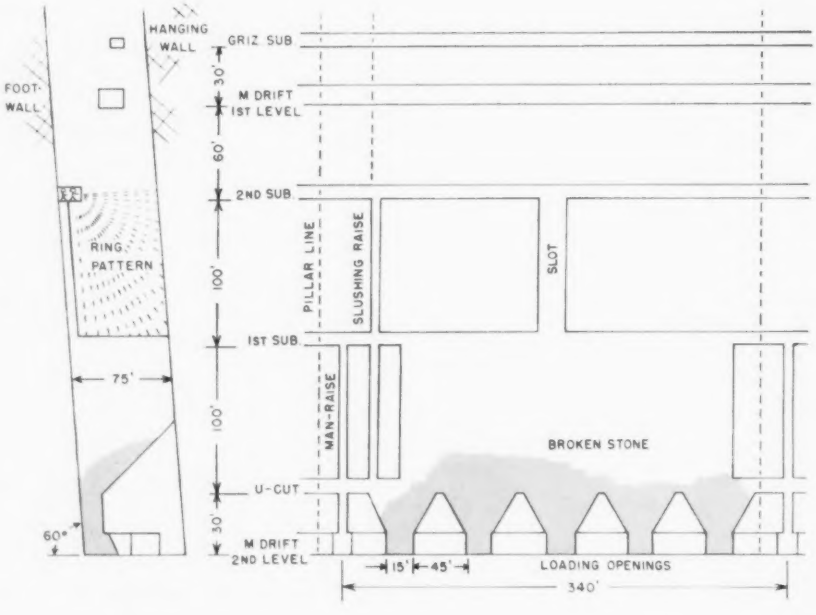


FIGURE 2: When the second level was opened and with the adoption of the sublevel stoping method, blast-hole drilling was changed to a ring pattern in a vertical plane.

tinued in that manner until the increased depth forced an underground operation, which began in 1936. National Gypsum Company acquired control in 1940.

Underground Mining Operation

To begin the underground operation, an inclined shaft at 18½° was driven approximately 1,200 ft. south of the limestone formation; this intersected the bed at the 300-ft. level. A 30-in. conveyor belt was installed to carry the limestone to the surface. A gyratory crusher located on this 300-ft. level performs the primary crushing operation.

The shrinkage stope method of mining was used on this level (see Figure 1). This consisted of mining stopes 300 ft. in length with 40-ft. pillars between stopes. The width from footwall to hanging wall averaged 70 ft., with a height of approximately 200 ft. depending on the surface elevation. Sufficient pillars were maintained to prevent caving and break-through to the surface.

The broken stone was loaded into cars from chutes and raises that were located between the main drift and a grizzly drift 30 ft. above the main drift. Five chutes were provided for each stope and the stone fragments were drawn from the stope through the finger raise at the subdrift, reduced in size by blasting and sledging to pass a 10-in. grizzly.

Stoping Procedure Changed

Originally, stoping operations were performed by drilling and blasting horizontally along the footwall and hanging wall. The breakage with this method was not satisfactory and left much to be desired as the center portion fragmented in large pieces because of the excessive burden on the holes. This method also presented the problems of trimming the roof to assure safety and the control of drawing the stopes to provide the desired working height.

With the successful advent of diamond drilling, the shrinkage stoping operation was performed by drilling 150-ft.-long horizontal holes from each end of the stope to the center. This improved the afore-mentioned conditions, but they were not really solved until the opening of the second level and a change to sublevel stoping methods (see Figure 2).

With the opening of the second level and the adoption of the sublevel stoping method, blast-hole drilling is now done in a ring pattern in a vertical plane. The grizzlies and car-loading pockets have been replaced by a Joy loader 18 HR which loads direct from stope openings on the haulage-level elevation.

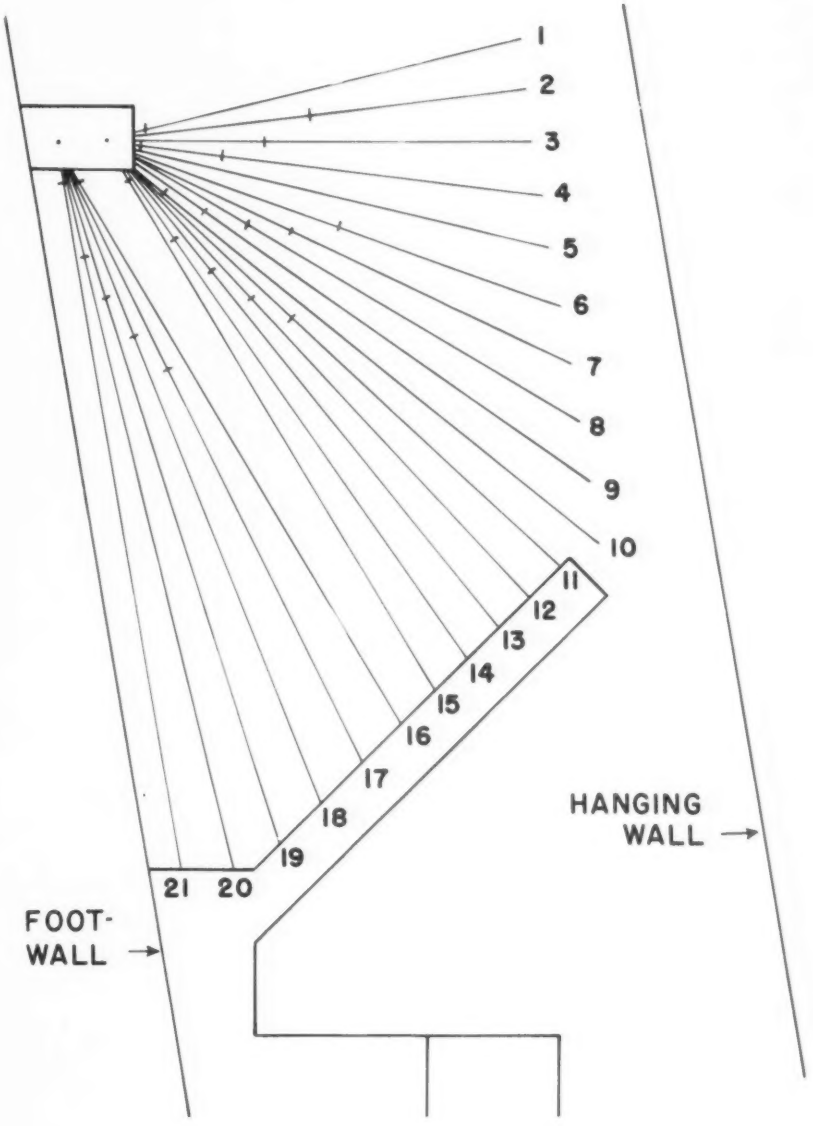


FIGURE 3: Ring-drill rounds similar to the pattern shown in this diagram are drilled parallel to the slot at 8-ft. intervals and blasted into the open cut. The holes range from approximately 54 to 95 ft. in length and are loaded with Gelamite 1.

The same stope dimension and pillar pattern as previously described were maintained. A 12 by 16-ft. haulage drift is driven in the good limestone about 30 ft. away from the footwall. Five loading openings are driven off the haulage drift perpendicular to the footwall. Belled finger raises are driven from the end of the loading openings into the stope.

In each pillar between stopes a raise is driven to the level above. Thirty feet above the haulage level along the footwall a drift is driven, which opens the top of the finger raise. From this drift the stope is undercut. One hundred and thirty feet above the floor at the haulage level another drift is driven along the footwall. This elevation forms the top of the first sublevel block that is to be mined. At an elevation 230 ft. above the haulage level a drift is opened along the footwall, which opens the second sublevel block of the stope. The third block of the stope is mined from the first-level opening.

Raise Driven in Center of Stope

To bring a stope into production a raise is driven in the center of the stope from the undercut drift to the sublevel drift above. At each sublevel a crosscut is driven from the raise to the hanging wall and, by diamond drilling, the raise is widened to a slot across the stope. Ring patterns similar to those shown in Figure 3 are then drilled parallel to the slot at 8-ft. intervals and blasted into the open slot.

The stope is undercut by driving a 45° raise to the hanging wall. Holes are drilled parallel to the raise and blasted to the raise previous to ring blasting.

The broken stone is loaded by Joy 18 HR loaders into 10-ton-capacity cars which are trammed to the crusher station. The loaders operate in a position at right angles to the haulage drift, with the boom of the loader extending over the cars making it possible to load the train without switching the cars.

The mine product is crushed and screened in sizes from ¾ to 2½ in. The larger sizes are used for calcining in

MAIN HAULAGE LEVEL: A miner drills on the main haulage level from a platform.

LOADING: A Joy loader operating in development work at National Gypsum's limestone mine.

rotary kilns to produce quicklime. The smaller sizes are used in the limestone plant to produce various limestone products for agriculture and industry.

Drilling and Blasting

An HS 15 Joy diamond drill in the Ex size is used for all the stope drilling at this location. This machine, manufactured by the Wheel Trueing Company of Detroit, Michigan, is equipped with a pilot-type diamond drill bit 1½-in. diameter. The bit is set with 13 or 14 carats of bortz diamonds which result in rapid penetration of the bit. Life expectancy of this bit averages 4,000 ft. although, on occasion, bits have drilled over 14,000 ft.

For development work various percussion-type drills are used: DB-30, DB-35 Ingersoll-Rand drifter; CP-50N Chicago Pneumatic; and R94 Gardner-Denver stoper. All of these drills use a 1⅞-in. D.I.R. jackbit.

The percussion-type drills mentioned previously are used in the development work for driving drifts and raises. The development headings are driven 8 by 14 ft. in size. A drilled round consists of 28 holes drilled on 2-ft. centers and 9 ft. deep, using a conventional "vee" cut. These holes are loaded with a 60% semigelatin dynamite (1½ by 12-in. cartridge) with approximately 4.60 lb. of dynamite per cu. yd. of material in the solid. This charge is detonated by blasting caps and safety fuse which in turn are initiated by Ignitacord*. The Ignitacord off the Ignitacord trunk line is cut in lengths to assure the center holes igniting first and their igniting outward from the center. This method gives excellent breakage and permits easy removal of the fragmented stone.

The diamond drill stoping holes are drilled in a ring pattern on 8-ft. centers with varying depths, as shown in Figure 3 which represents a typical stope shot. These holes are loaded with 1¼ by 24-in. cartridges of Gelamite® 1 (a 60% semigelatin dynamite) on the basis of 0.525 lb. of dynamite per cu. yd. of material in the solid. A 40-grain Primacord* downline primes the first cartridge. The holes are then tied in to

*Reg. U. S. Pat. Off. by The Ensign-Bickford Company

a Primacord trunk line. A total of eight MS connectors is positioned along the trunk line to achieve the desired delay, which depends on the condition of the hanging wall, although it is generally delayed toward the slot opening of the stope. While this method results in good breakage, some secondary shooting is necessary. The secondary shooting is accomplished by conventional mud-capping methods using a 60% dynamite initiated by Primacord.

Crushing and Stone Preparation

We have now traced the stone from its origin into the 10-ton mine cars used to transport the stone to the primary 30 by 60-in. single-roll crusher, manufactured by the Pennsylvania Crusher Company, located in a pocket on the main drift of the second level. From this primary crusher the stone is transported on a 30-in.-wide conveyor belt to the 16-in. gyratory crusher located in a pocket on the first level. This secondary crusher, manufactured by the Traylor Company, discharges stone 2½ in. and under in size onto another 30-in. belt for transportation to the crusher house on the surface.

In the crusher and junction house the stone is reduced in size. This is accomplished by the use of a No. 7½ Traylor gyratory crusher and a triple-deck distributing screen which separates the broken stone into the size group in which it belongs and deposits it on a conveyor belt for transportation to its eventual destination. Any stone larger than 2½ in. is fed into a Traylor No. 8 gyratory crusher which reduces the size, and the stone is again passed over the triple-deck screens.

Description of Plant

The stone is now ready for the various procedures necessary for the production of the finished product. From the kiln stone storage and kiln stone feed building the stone is fed into large rotary kilns for the calcining process. Here the raw stone carbonate is subjected to heat; this reaction yields oxides of calcium plus carbon dioxide. From here the oxides are passed through lime coolers to the lime storage silos to await processing for load-

CRUSHER STATION: Ten-ton-capacity cars are trammed to the crusher station.

LIMESTONE PLANT: View of the mine surface and plant buildings of the limestone mine and plant.

ing. The lime is stored in the silos by size and can be recovered selectively as desired.

The lime fines, which have been recovered throughout the various production steps, are processed through the hydrate plant. Here, water is added to the lime fines in a Schaffer continuous hydrator. This reaction yields calcium hydroxide, and steam is released. The hydrated lime is then passed through a separator pulverizer to the bag-filling machines or to the screw conveyor to truck loading.

The limestone screenings are processed through the flour plant via a rotary drier and Raymond roller mill through the cyclone to the pulverized limestone bin for bagging.

Plant Management

The National Gypsum headquarters are in Buffalo, New York, under the leadership of President Fred A. Manske. Directly under his supervision is Leonard L. Hank, vice president in charge of operations. R. E. Gill, production manager, completes the Buffalo chain of command insofar as the Bellefonte Mine is concerned.

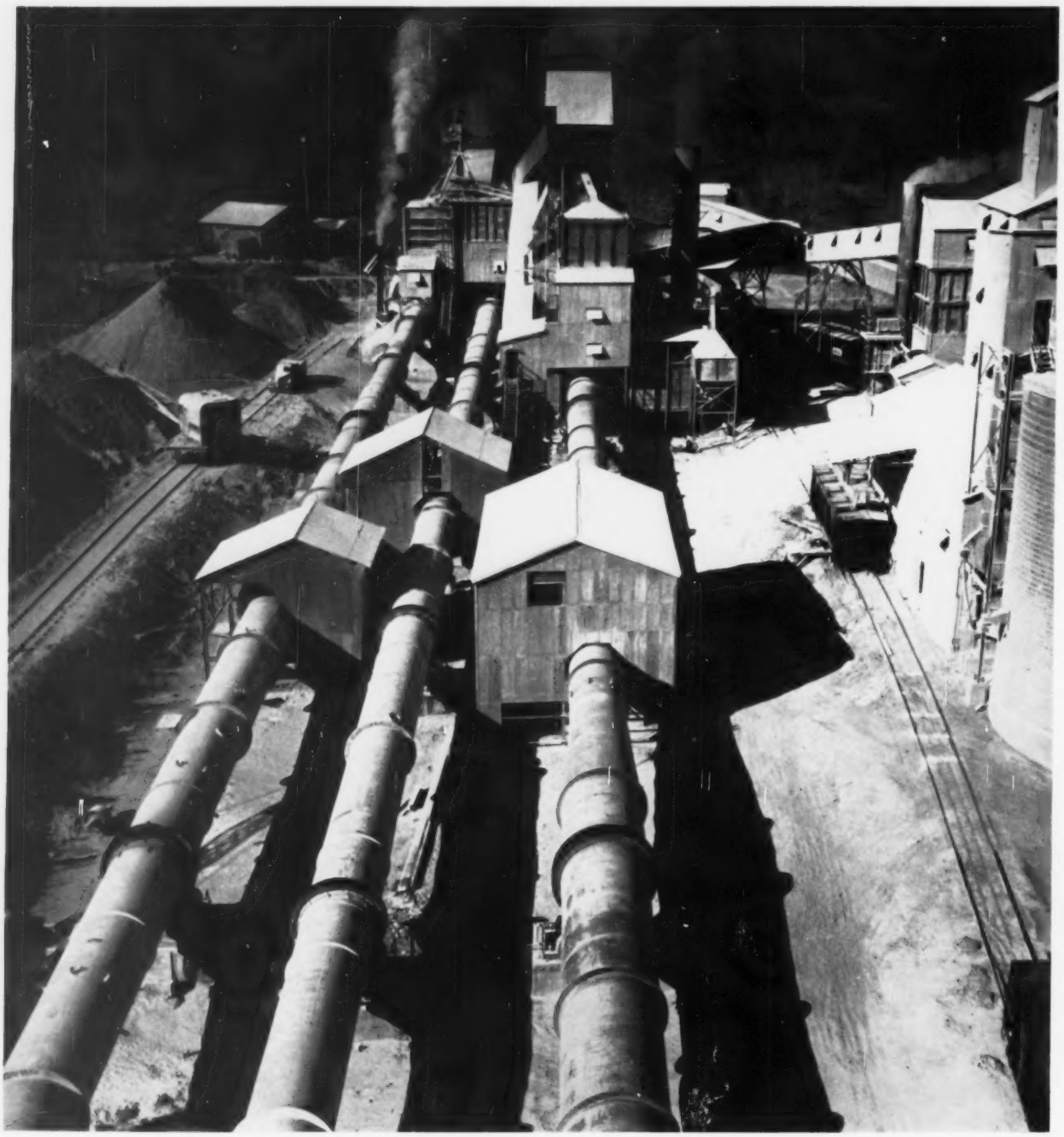
On the local scene, the Bellefonte operation is in the capable hands of H. E. Gustafson, the plant manager. R. Carlson is superintendent of maintenance; P. Bartram is surface superintendent; and J. Pinto is superintendent of mines. Under each of these departmental supervisors and their foremen, the daily work is planned and executed with the utmost efficiency and diligence.

National Safety Competition Winner in 1957

When the Safety Division of the U.S. Bureau of Mines computed its figures to determine the winner of the National Safety Competition among the underground mines producing nonmetallic minerals for the year 1957, the winning contestant was the Bellefonte Mine. This mine worked a total of 313,925 man-hours in that year without sustaining a lost-time injury, a record indicative of the thoughtful planning and efficient execution with which men and management proceed with their daily work.

The award of the Sentinels of Safety trophy recognizes a safety record better than that of any other nonmetallic mine in the United States for the 1957 calendar year. This is a significant accomplishment as it represents a cooperative group effort of all employes at the plant and mine in working toward an accident- and injury-free year.

The backbone of the company's safety program is the group safety meetings at which 90% attendance is considered poor and perfect attendance is stressed. Besides these meetings a foremen's meeting is held monthly where interest is stimulated by a program consisting of films, speakers, and topics of interest which continuously stress safety. The company also has a 100% eye- and foot-protection program, but the main contribution to its enviable safety record is the worker who thinks and acts with a safety-conscious mind and attitude.



LIMESTONE TREATMENT: Limestone for agriculture and industry is mined and processed at this plant.

Operation Todhunter

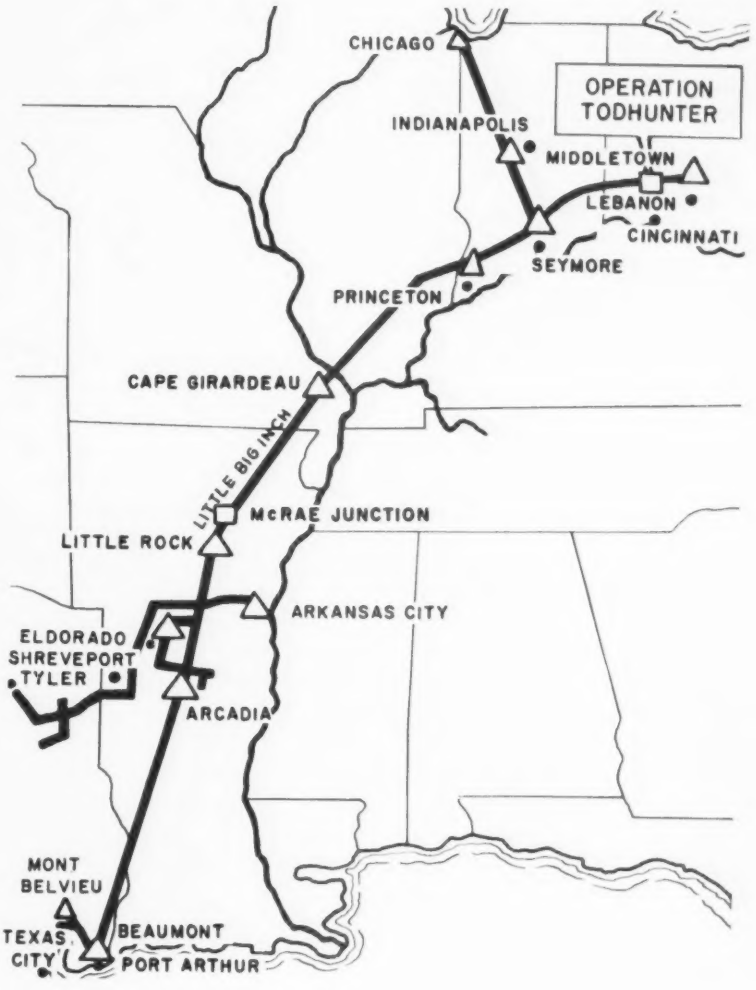
Large-scale mining project near Middletown, Ohio, will provide safe, low-cost underground storage for liquefied petroleum gas

R. L. ROUGH*

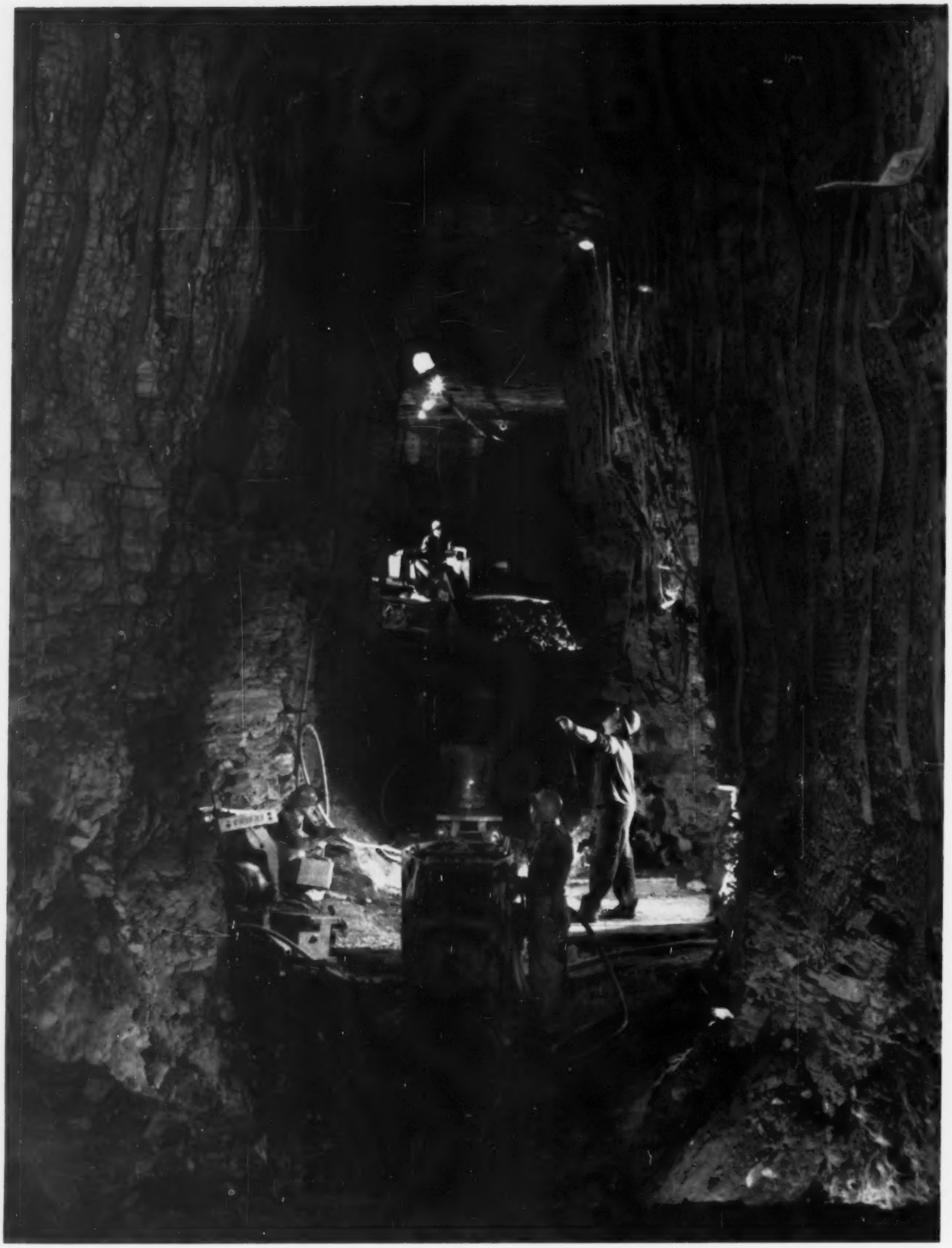
RECENT advances in our Space Age tend to dwarf less dramatic, but equally important, developments in other fields. One of these developments in a world at peace is "Operation Todhunter," with Fenix & Scisson, Inc., proving that rockets, Sputniks, and ICBM's have no monopoly on men of imagination. Operation Todhunter, a large-scale mining project, will provide underground facilities for the storage of LP gas to meet the rapidly expanding marketing operations of the Texas Eastern Transmission Corporation.

In simple terms, LP gas is either butane or propane gas and is extracted from crude oil, or natural gas. When stored under pressure, the gas liquefies. That's how it gets its name, liquefied petroleum, or LP, gas. LP gas readily vaporizes to a dry, clean-burning gaseous fuel which is used chiefly for residential heating and cooking; however, its use as a motor fuel is growing rapidly.

The Texas Eastern Transmission Corporation of Houston, Texas, operators of the Little Big Inch pipeline, will transport LP gas from its Gulf Coast facilities to the Eastern and Midwestern sections of the United States. The rural countryside of Middletown, Ohio, site of this mined LP gas-storage cavern, is being transformed into an ultra-modern storage, processing, and distribution terminal. The initial phase of the mining project is expected to cost about $3,500,000, and will



*Hercules Powder Company
Pittsburgh, Pennsylvania



CONSTRUCTING A CAVERN: Some 350 ft. below the surface the miners have enlarged the working space so that various types of mechanical equipment can be utilized. Most of the equipment used underground was lowered in sections and reassembled.

have a total capacity of approximately 850,000 net barrels.

Major factors influencing underground storage of LP gas are savings and safety. Underground storage costs run approximately $4 to $6 per barrel, while surface tank storage runs about $25 per barrel. Also, in the event of an atomic war, underground storage is obviously more desirable than tank storage above ground.

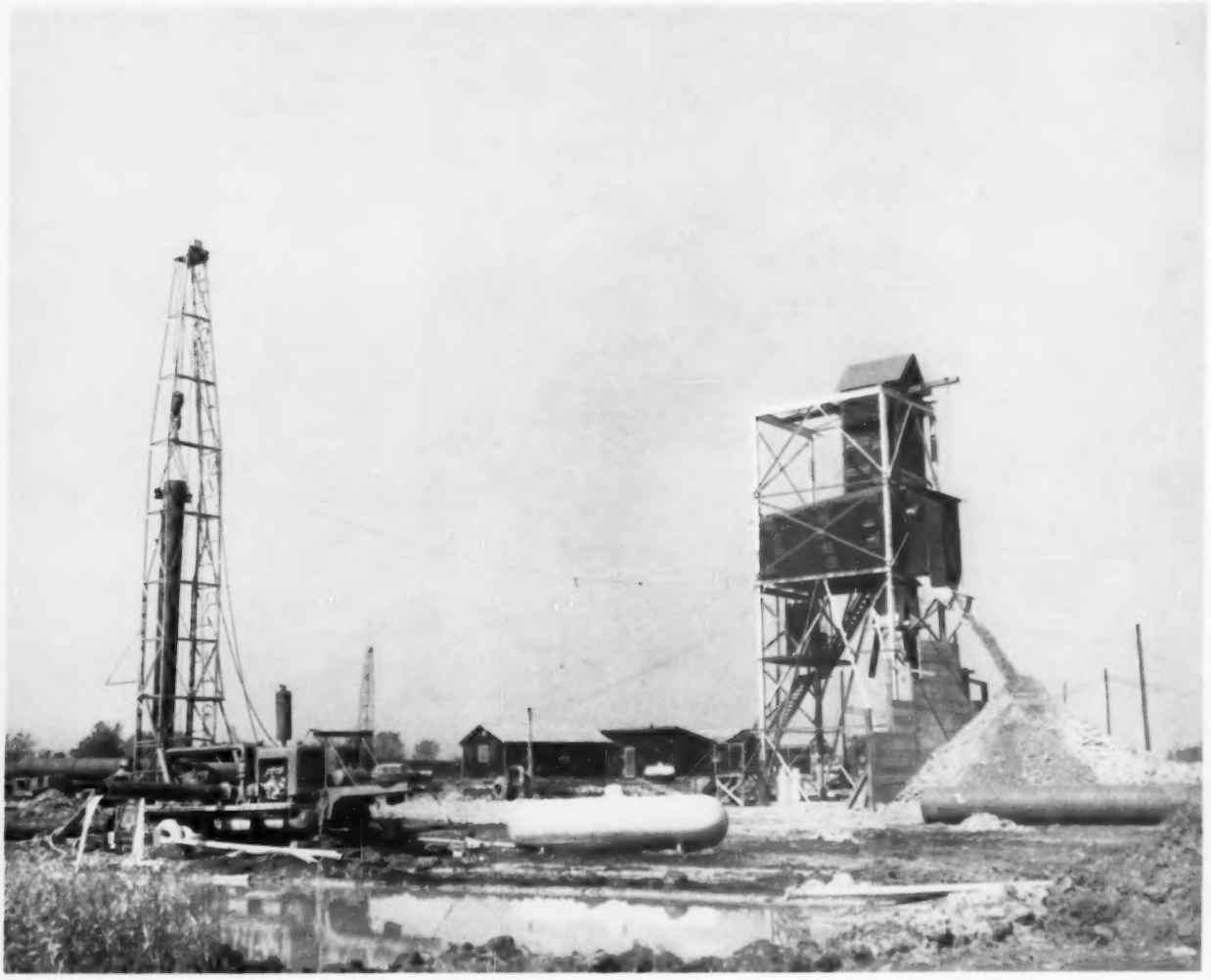
The tentative completion date of the original project was August, 1959, but the economical advantages of mined LP gas storage have created so much interest among fuel suppliers that additional caverns are being mined, which has altered the completion date.

The Cincinnati Gas and Electric Company is spending approximately $700,000 on cavern mining, and another $1,000,000 on an adjoining processing plant to help meet the extra demand for its gas during near-zero weather. As much as 50,000,000 cu. ft. of gas per day will be provided. A similar cavern is being constructed for Dayton Power and Light Company. Of three others under construction, one has been leased to Phillips Petroleum Company, one is reserved for the use of Texas Eastern, and one will be leased to Texas Eastern shippers.

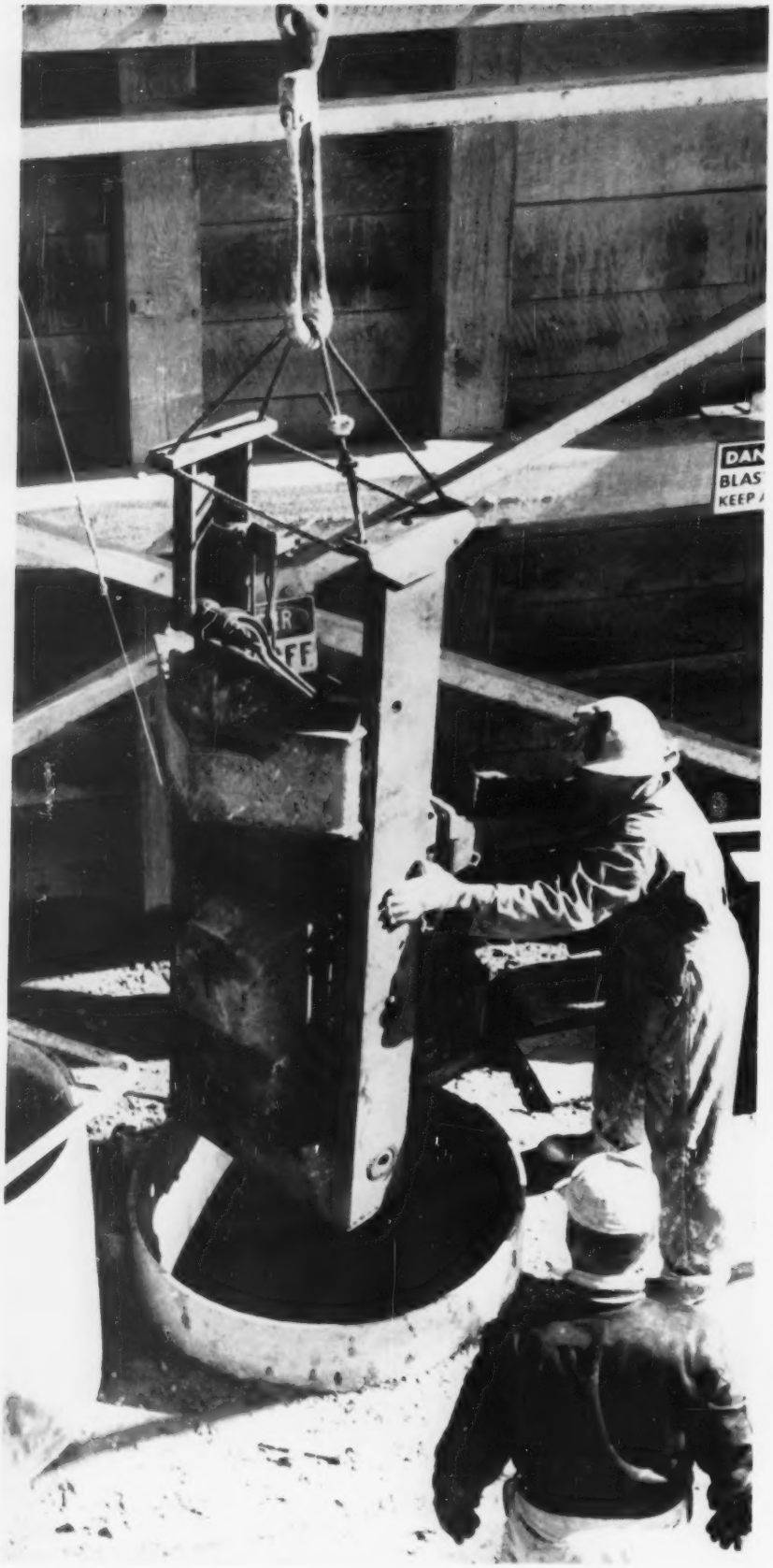
Geological Studies

To determine the feasibility of underground storage caverns in the Middletown, Ohio, area, Texas Eastern engaged the services of Fenix & Scisson, Inc., underground-storage-cavern specialists of Tulsa, Oklahoma. Extensive corings were made 3 miles south of Middletown. The rock strata are classified as sedimentary in origin and consist of shales and limestones of the upper Ordovician system. The surface of the region is comparatively flat. Directly underlying the soil is glacial drift with a thickness of 60 ft.; from 60 to 130 ft., fossiliferous shale with thin streaks of limestone is found; and from 130 to 402 ft., 75% gray calcareous shale, generally firm but crystalline, hard, fossiliferous with limestone stringers.

No unusual physical curiosities were encountered, and it was determined that the shale formation was ideal in all respects for storing LP gas. Al-



SURFACE OPERATIONS: The Failing rotary drill and tipple in operation. The excavated shale, hoisted through the shaft, pours from the tipple.



though easily decomposed when exposed to the weather, the shale forms a solid mass when compacted, because of its minute structure.

Shaft Drilling

The project was actually started April 28, 1958, when the drilling subcontractor, J. P. Miller Artesian Well Company of Brookfield, Illinois, moved in with three rigs. Miller is using two Failing Jed-A units and a Failing 1500 Holemaster. The Jeds are being used both for conventional-type drilling and reverse circulation. The mine shafts, air shafts, and escape shafts are being drilled with the rotary drills. The mine shafts are 52 in. in diameter and are cased with 42-in. steel pipe welded together in 30-ft. sections. The air shafts are drilled 17 in. in diameter and cased with 12-in. pipe. The escape shafts (required by the State mining law) are 26 in. in diameter and cased with 20-in. pipe. All holes are drilled to depths of 355 ft.

Drilling of the 52-in. holes for the mine shafts is done in three stages. The pilot hole is drilled by conventional rotary methods using a Failing 1500 rig with a 5⅞-in. tricone rock bit. When the pilot hole is completed, an Eastman survey is run to determine the vertical alignment. If the pilot hole meets the specifications, it is reamed to 20 in. The hole is then reamed from 20 in. to a diameter of 52 in.

Running Pipe

When a mine shaft is completed, the drill rig is moved ahead 2 ft., and an A-frame derrick is set up to run the 42-in. casing, with ⅜-in. walls. Casing is run straight, instead of being floated into the hole, and to a depth of 340 ft. The total string of casing weighs about 105,000 lb. Cement tubing is placed on the outside of the pipe, and the annulus between the casing and the rock

TIGHT SQUEEZE: All the equipment for use underground had to be dismantled, and the parts lowered through the 42-in. casing. Here, a bulldozer motor assembly is being guided through the narrow shaft.

is filled completely with neat cement grout.

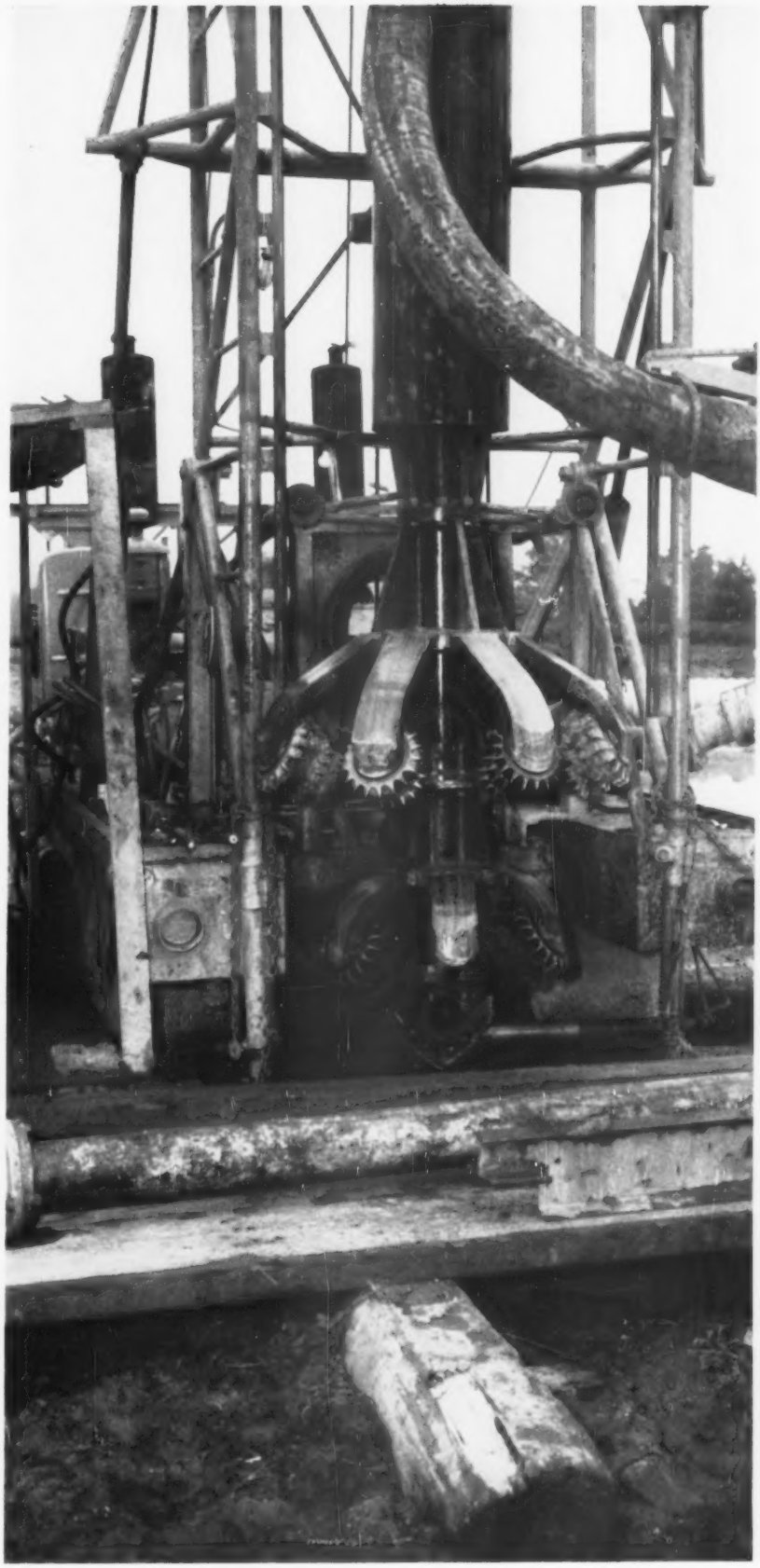
As mentioned previously, the shale is extremely compact, and no lining of the tunnels is required. The last stage is to erect a 60-ft. steel derrick (head frame) equipped with an electric hoist. As soon as the miners have excavated sufficient rock to make adequate working space at the shaft bottom, Allis-Chalmers front-end loaders and Eimco air-operated Rockershovels are sent down in sections and reassembled at the bottom. One observer likened this particular operation to the "threading of a needle."

Tunneling Method

As with all shaft mining, the initial lateral advance from the shaft consists of drilling and firing small shots, which are then removed by laborious hand-shoveling. When the mucking cycle gains impetus, and sufficient working space is available, jack-leg drills are used to drill the now-established working face.

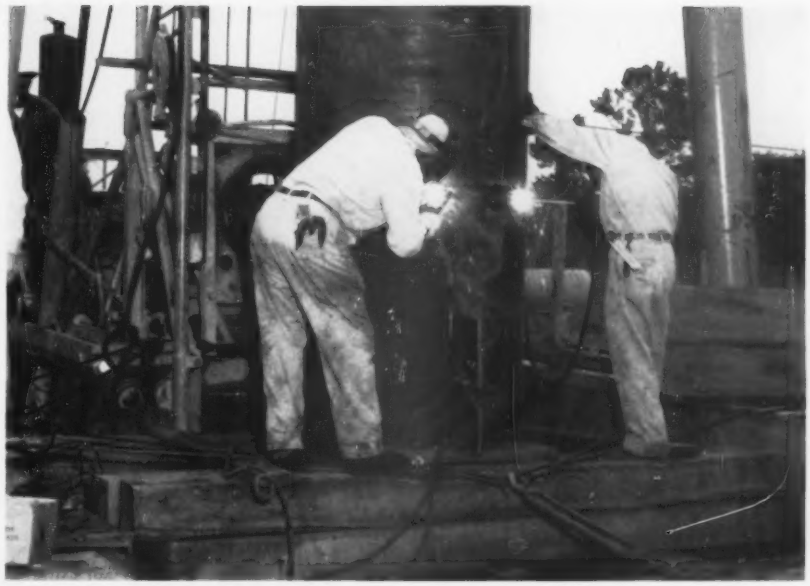
The excavation is accomplished by the room-and-pillar method, with the pillars driven on about 50-ft. centers. The rooms are 16 ft. high, 10 to 12 ft. wide at the roof and at the base. The upper 8 ft. of the rooms is driven 20 to 25 ft. in advance of the bottom portion. This method facilitates the scaling of the roof and the installation of roof-support bolts when necessary. The miners prefer either a hammer-cut or burn-cut, but type of cut is predicated by actual drilling conditions. In both rounds, Gelamite® 2, a semigelatin type of dynamite, in 1¼ by 16-in. cartridges, is used in the cut and lifter holes, as well as in the remaining holes. The holes are primed with No Vent® Delay Electric Blasting Caps from 0 delay up to and including the seventh delay.

The blasted material is transported from the heading to the shaft by Allis-Chalmers front-end loaders. At the



BIG BIT: For the third stage of drilling the shaft, this huge bit will be used to enlarge the shaft diameter to 52 in.

READY FOR HOISTING: All excavated rock loaded into ½-cu. yd. buckets had to be hoisted about 350 ft. through a 42-in. shaft.



WELDING CASING: The shafts are lined with 42-in.-diameter 30-ft. lengths of steel pipe sections welded together.

shaft, the material is then loaded into ⅝-cu. yd. cylindrical buckets by Eimco air-operated, track-mounted Rocker-shovels. When a cavern is completed, all equipment is disassembled and brought to the surface. A tank head is welded on the casing shaft and the cavern is tested to withstand 120-p.s.i. pressure.

With work going on around the clock, tunnel crews have been working three 8-hour shifts. Fenix & Scisson employs about 160 men on this project.

The LP gas will be pumped as a liquid from the cavern to the processing plant, one mile east of the cavern site. There it will be gasified, mixed with natural gas, and distributed to the consumer. The Chinese of 1000 B.C. would stare in amazement if they could see today's modern methods of fuel transmission. The Chinese of that period burned natural gas under brine vats to make salts, and the gas was transported from the ground to the vats through bamboo sticks.

Key Men

Fenix & Scisson, Inc., well known in the underground-storage-construction field, has the following personnel handling the Todhunter project: S. E. Scisson, president; C. E. Stover, general superintendent, mining division; W. L. Woodmansee, project superintendent; and A. Kuklis, project engineer. The men in charge for Texas Eastern Transmission Corporation are: Paul G. Doran, project engineer, and R. L. Yancey, terminal supervisor.

The Todhunter terminal with its tremendous capacity represents another step forward, for imaginative men have found a way to transport oil long distances through pipelines, to meet the ever-increasing demand for heat and energy.

ALMOST COMPLETED: This section of a pillared cavern is undergoing cleanup operations. Pillars were left standing to give support and prevent roof fall or cave-ins.

LOOKING DOWNSTREAM: The Mammoth Pool Dam is located in a natural steep-walled rock canyon.

The Mammoth Pool Hydroelectric Project

Nearing completion in the high Sierras, a huge hydroelectric plant will help meet the ever-increasing demand for electric power in Southern California

NEVILLE S. LONG*

THE Mammoth Pool Hydroelectric Project, now in the course of construction for the Southern California Edison Company, will add 126,000 kw. of electrical energy to the company's generating facilities at Big Creek. The Big Creek system, which now comprises five major lakes and seven powerhouses, is located high in the Sierras about 80 miles northeast of the city of Fresno. The system uses the waters of the San Joaquin River and now produces 349,000 kw. The Mammoth Pool project, a part of a plan to further utilize the hydroelectric potential of the San Joaquin River and its tributaries, will cost an estimated $50 million when completed. When the Mammoth Pool project is in operation, the total power supplied by this section of the system will be 666,000 kw.

The project has experienced a long history of planning and negotiation dating back to the 1890's. The plans were started in 1951 when the Edison Company filed a request with the Federal Power Commission for a license to construct a 126,000-kw. powerhouse. Negotiations for the use of the water of the San Joaquin River by the project have been in process with the Bureau of Reclamation for six years and were successfully concluded with

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Northfork, Calif.

the execution of a contract with the Bureau in September, 1957. The Federal Power Commission issued a construction license for the project and actual work commenced in January, 1958, with the construction of the access roads and the diversion tunnel.

The project consists of the Mammoth Pool Dam, located on the San Joaquin River about 9 miles upstream from the company's Big Creek powerhouse No. 8; an 8-mile 20-ft.-diameter power tunnel and a two-unit, 126,000-kw. powerhouse as well as appurtenant structures. The dam will have a net height above stream bed of about 330 ft., and a gross height above bedrock of about 440 ft. It will be of rolled earth-fill construction and will require about 5,000,000 cu. yd. of fill. The crest length of the dam is 820 ft. and its length from toe to toe will be approximately 1,800 ft. A reservoir 8 miles in length with a gross capacity of 123,000 acre-feet will be created by the backed-up waters.

The water conduit connecting Mammoth Pool Reservoir with the powerhouse will be approximately 40,000 ft. long. This will be a 20-ft.-diameter tunnel driven through granite and will be lined at points deemed necessary because of poor support or insufficient cover. The invert of the conduit will be paved with concrete. Two small diversion dams will be constructed on creeks crossing over the tunnel, and bore holes will be drilled so that the water from each of these creeks will be conducted downward into the tunnel.

The Mammoth Pool powerhouse will be located on the San Joaquin River at the upstream end of the existing afterbay for the company's Big Creek Powerhouse No. 8. It will be an outdoor type of powerhouse and will contain two generating units, each having a vertical-shaft reaction turbine directly connected to a 63,000-kw. generator. The combined power rating of the two units will be 126,000 kw. The powerhouse will be operated by remote control from one of the company's other Big Creek powerhouses.

Additional Construction

In addition to the main items of the project, 15 miles of new roads and bridges across the San Joaquin River and Chiquito Creek had to be constructed.

A transmission line will be constructed to interconnect the new powerhouse with the company's existing Big Creek transmission line system. The electric energy generated at the powerhouse will be raised from 13,800 volts at the generators to a nominal 220,000 volts for transmission. The present transmission lines from Powerhouse No. 3 to Los Angeles are capable of carrying the added generation of the Mammoth Pool project.

A 28 by 2,200-ft.-long diversion tunnel was constructed through solid granite to by-pass the San Joaquin River around the damsite during construction. Contractors for this work were Morrison-Knudsen, Macco, Kaiser, Shea. Progress on this portion of the project was outstanding, with the tunnel being driven in a total of 64

CUTOFF TRENCH: Excavating the 332,960 cu. yd. in the cutoff trench was difficult because the material was interspersed with large boulders that required drilling and blasting. A variety of shovels was used in excavating the material.

BLASTING IN THE CUTOFF: A drilling pattern spaced on 8-ft. centers was used in the cutoff area which consisted of compacted pervious material and many large boulders. If the drill hole failed to hit rock, it was left unloaded.

calendar days and the entire work being completed in a total of four months. Because of its importance to the project, the contract for the diversion tunnel contained a bonus-penalty clause. As a result of efficient planning, this work was completed 35 days ahead of the specified completion date, and the contractor received a substantial bonus.

The Bechtel Corporation is the designer for the dam, penstock, and the powerhouse. In addition, it is constructing the dam and the powerhouse and under a labor-management contract it is using Edison-owned equipment for this portion of the work. Both tunnels were designed by Edison's own engineering staff, with the power tunnel being constructed by the Utah Construction Company, whose low bid of $12,359,655 resulted in its receiving the largest single construction contract ever awarded by the Edison company.

A Joint Venture

It is interesting to note that four of the original six companies that pioneered the joint-venture concept for heavy construction with the construction of Hoover Dam are included among the contractors working on the Mammoth Pool project. These are the Bechtel Corporation, Utah Construction Company, Morrison-Knudsen Inc., and Kaiser Engineers. The access roads to the powerhouse and bridge across the San Joaquin River were constructed under contract by Harms Brothers and Thomas, with other road construction on the project being done by the Bechtel Corporation.

The steel penstock is a single pipe varying in diameter from 11 to 13 ft., with a wye branch just above the powerhouse for distributing the water to the two units. The penstock is being fabricated and installed by Consolidated Western Steel Corporation.

The two 63,000-kw. Westinghouse-furnished generators will be driven by two 88,000-hp. Francis-type reaction turbines manufactured by Allis-Chalmers Company (formerly S. Morgan Smith Company) and will operate under a static head of 1,105 ft. This is the highest head under which the Francis type of turbine is operated in this country, as far as we know.

After diversion of the river in May of 1958, the construction schedule called for the excavation of a cutoff trench to bedrock and the filling of this trench with compacted, impervious material by the fall of 1958 prior to the season when a major flood could be expected. In the spring of each year the San Joaquin River normally experiences a heavy run-off from melting snows in the higher reaches of the drainage basin. In addition, extremely heavy floods occur from time to time in the fall of the year because of concentrated warm-type storms which produce rain to about 8,000-ft. elevation. The possibility of such a storm occurring in the fall of 1958 was about one in eight. As these fall floods have peaked at more than double the highest spring flooded record, the construction program described was adopted to save the cost of a second diversion tunnel. Should a flood of this magnitude have occurred, it would have passed through the damsite with relatively minor damage, as the dam was at approximately the old river

bed elevation at that time.

Drilling Pattern

As will be seen in the picture, the damsite is in a steep-walled rock canyon. In the remote past, a series of rock falls had created natural dams by filling the canyon to a depth of about 120 ft. with sand, gravel, and boulders ranging up to 50 ft. in diameter. As a result of being subjected to constant saturation, the material, although pervious, was solidly packed and presented a difficult excavation problem. Because of the presence of so many large boulders, the material could not be excavated without drilling and blasting, and the random manner in which these boulders were scattered throughout the material created a situation that made it impossible to drill each boulder individually. After some trial and error, the Bechtel Corporation adopted a program of pattern drilling, with the holes spaced on 8-ft. centers. If a hole failed to hit a rock, it was not loaded. This system worked quite satisfactorily although when very large boulders were encountered, some secondary drilling and blasting were necessary.

Drilling was done with a fleet of 12 Gardner-Denver 123 Air-Trac drills using 2⅝-in.-diameter carbide insert bits supplied with air from two 600- and five 900-c.f.m. Gardner-Denver rotary compressors. Air was delivered to the drills by aluminum 4- and 6-in. pipe. Gelamite* 2, a semigelatin type of explosive, in 2 by 12-in. cartridges, and Hercol* Bag Powder were used, with detonation by both Primacord* and Hercules* Short-Period Delay Caps, periods 1 through 10. Because of the nature of the material, which consisted of sand, gravel, and boulders, and the fact that many holes did not require any powder, excavation was accomplished with an average use of approximately 0.8 lb. per cu. yd.

Excavation of the 332,960 cu. yd. in the cutoff trench was handled by one Bucyrus-Erie 88B shovel, two Northwest 80-D shovels, one Lima 1201 shovel, and one Manitowoc 3500 crawler shovel. The material was hauled out by a fleet of ten International Payhauler trucks of 16-yd. capacity.

In order to create a watertight barrier, an extremely good contact between the rock abutments and the impervious core of the dam must be obtained. Because an earth dam is subjected to considerable settling during construction as well as some additional postconstruction settlement, placement of the core material against any overhanging rock faces would create a definite possibility of a void developing as the material settled away from the rock. To prevent this, the designers specified that all rock be sloped back to 70° from the horizontal, or on approximately a ¼ to 1 slope. This requirement necessitated the removal of approximately 50,000 cu. yd. of solid granite from the abutments. Most of this work was handled by the Air-Tracs, with some of the smaller, isolated sections being drilled with jackhammers. Gelamite 2 was used for this work, with a ratio of approximately 1 lb. of explosive per cu. yd. of material. Firing was by means of Hercules Short-Period Delay Caps.

Spillway Excavation

The other major excavation problem in connection with construction of the dam was the removal of approximately 400,000 cu. yd. in the spillway. Located in a natural saddle on the right-hand side of the dam, the spillway is designed to pass a flood of 170,000 cu. ft. per second. The maximum cut in the spillway excavation is 104 ft. and the width of the spillway at the crest is 403 ft. A small concrete weir structure will be built to serve as a control crest for this ungated spillway. The major part of the spillway channel will be unlined.

It was expected that the spillway excavation would consist of almost 100% solid rock excavation; however, as often occurs in the lower elevations of the main Sierra granite structure, a large amount of highly weathered rock was encountered in this area. From a construction viewpoint, this was particularly bothersome since the rock was extemely nonuniform. In any given 10-ft. cube, the rock could range from good, hard granite to rock that could be readily broken to grain-size particles with a few blows of a hand hammer. In addition, this area contained many seams, which further complicated the excavation problem. If this condition had not been present, excavation costs would have been lower. The presence of seams caused many holes to blow out, thus dissipating the energy of the blast. Design

*Reg. U. S. Pat. Off. by The Ensign-Bickford Company

SPILLWAY AREA: A Bucyrus-Erie 88B digs into the blasted rock in the spillway area. The use of Hercules Short-Period Delay Electric Blasting Caps helped prevent excessive backbreak.

of the dam anticipated using the material resulting from the excavation as rock fill; but since less than half of the rock excavated was suitable for this purpose, it was necessary to revise the design and to substitute rolled fill.

Blasting of the spillway excavation was accomplished by the use of Dynatex®-BF, a nitro carbo nitrate blasting agent, furnished in 50-lb. bags. Detonation of the Dynatex BF was accomplished by means of a primer of Gelamite 2 in 2 by 12-in. cartridges, Reinforced Primacord, and Hercules Short-Period Delay Caps. A Titan® Blaster was used to detonate the short-period delay caps. The explosive ratio on the excavation work was 1 lb. of explosive per cu. yd. of material. It had been expected that this ratio would be about 0.7 and, if the material had been solid rock, it is believed that this factor could have been met. The presence of so many seams necessitated the use of additional explosives. The spillway excavation was carried out in 25-ft. lifts, with the drilling being done by light Gardner-Denver Air-Tracs with holes spaced on 8-ft. centers. Excavation of the blasted material was done with the Bucyrus-Erie 88B and Northwest 80-D shovels. International Payhaulers were used to move the material, with the good rock going into the downstream rock toe and the poor rock and disintegrated granite going into the waste zones in the dam.

®Hercules Trademark

Powerhouse and Penstock

Considerable rock excavation was required for the powerhouse and penstock installation. The rock encountered in this area was primarily diorite with heavy jointing throughout. A total of 50,115 cu. yd. of excavation was required for the powerhouse itself and an additional 52,625 cu. yd. of excavation needed for the penstock. The final reach of the penstock, 973 ft. in length, is on a 35° grade and excavation of this material presented special problems. Four access roads were constructed to different levels and the general procedure after blasting the rock was to move the material down the cut to one of these levels, where it was loaded out and hauled away. It was possible to operate a dozer down the grade by having it held back by a cable fastened at the top of the slope. Drilling was accomplished from a job-built drilling platform on which three Gardner-Denver LMR-6 wagon drills were mounted. This platform was also lowered by a cable from a winch and was so designed that the men stood on a working platform level with the drills, which were mounted so that they could drill perpendicular to the face. Gelamite 2 in 1¼ by 8-in. and 2 by 12-in. cartridges was used in the blasting operations at the penstock and powerhouse excavations, with detonation by both Primacord and Hercules Short-Period Delay Caps, periods 1 through 10. The explosive excavation ratio was 0.7 lb. per cu. yd. for the penstock rock and 0.9 lb. per cu. yd. for the powerhouse rock excavation.

The tunnel, being driven from five headings, has encountered very little bad ground and, out of the first 33,000 ft. driven, only 650 ft. required support. A world record of 390 ft. in one six-day week was set at the outlet heading in January of 1959.

The unusually dry winter of 1958-59 and the excellent ground conditions in the tunnel have contributed to the entire project's being ahead of schedule. It is expected that the powerhouse will be ready by April of 1960.

OUTLET PORTAL HEADING: Drilling a round from the middle deck of a three-platform jumbo. Very little bad ground was encountered in drilling the tunnel, which was worked from five headings. The entire project is considerably ahead of schedule.

Key Personnel

Key personnel on the Mammoth Pool Hydroelectric Project for the Southern California Edison Company include: W. L. Chadwick, vice president of Southern California Edison; R. W. Spencer, manager of the engineering department; P. B. Peecook, assistant manager of engineering; O. N. Kulberg, chief construction engineer; H. A. Barber, project engineer; Neville S. Long, resident engineer; T. M. Leps, chief civil engineer; and B. R. Laverty, senior civil engineer.

Representing the contractors are E. J. Garbarini, project sponsor; G. W. Saul, job superintendent; K. V. Taylor, project engineer; T. W. Grover, senior construction engineer; C. W. Lacey, field control engineer for the dam; and L. E. Garst, field engineer in charge of the lab. Field geologist is H. A. Spellman.

Project personnel for Utah Construction Company include Boyd C. Paulson, project manager; Steve Wilmoth, general superintendent; Al Simoneaux, project engineer; and H. W. Johnson, business manager. Portal superintendents are "Heavy" Holman, Jack Robertson, and Paddy O'Dowd.

Small Blasts Solve Unique Problem

A brief account of the successful use of dynamite to remove floor slab adhering to the roof

WILLIAM F. HALLSTEAD*

In the explosives industry, it has been said that the right man can do anything with the right explosives. This maxim was put to the test recently on Maryland's Eastern Shore, where there arose a blasting problem that almost defies rational description.

In fact, the first telephone request to the dynamiting company, Burnbrae, Inc., of Baltimore, Maryland, left that firm in some wonderment. "We have a floor stuck to a roof down here," the contractor's representative said with a degree of alarm. "Can you blast it loose?"

What had happened was actually quite simple, but highly unusual. A barrack-type building for a correctional camp was being erected by the jacked-slab method. In this system, the floor slab is poured, allowed to set, then is used as the bottom form for the roof slab which is poured directly on the floor slab. The roof slab is then lifted by multiple hydraulic jacks and bolted into position atop the columns, which are already in place.

A separation compound is spread on the floor slab before the roof slab is poured, and this compound should prevent the two slabs from bonding together. In this particular case, something apparently went awry in the timing department. When the roof slab had set and was jacked aloft, 7,500 sq. ft. of the mesh-reinforced floor broke loose from its base and went along with the roof. Jackhammers, wedges, and crowbars were used, but to no avail. In desperation, the contractor sought the services of an explosives expert.

*517 Wyngate Road
Lutherville, Maryland

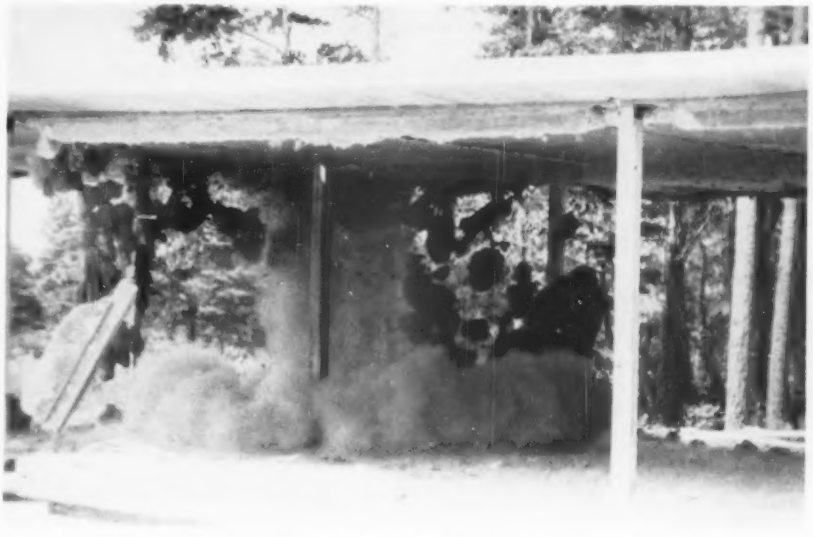
On this job, blasting was the last hope. The problem was a touchy one: the six adhered floor areas were to be blown off with no damage to the roof slab. The work called for the extensive use of fractional cartridge charges. Test shots proved the most practical arrangement to be 1-oz. loadings of 40% gelatin dynamite on an 18 by 12-in. grid spacing. This grid included more than 3,500 bore holes.

The roof slab was approximately 7 in. thick; the adhered sections of flooring were 4¾ in. in thickness. The bore holes were drilled to butt against the bottom of the roof slab. They were loaded first with an inch of clay, then the ounce of gelatin with its instantaneous electric blasting cap, and then 2 in. of clay stemming.

Several dozen holes were loaded at a time and the shunted leg wires left dangling. After a large area was loaded, the charges were connected in groups of four and fired with a regular blasting machine.

The exacting work, requiring three weeks, paid off. All adhered floor sections were blasted free without any damage to the roof slab.

SMALL CHARGES: The explosive charge in each bore hole consisted of 1 oz. of 40% gelatin dynamite. Holes were spaced on an 18 by 12-in. grid, and the charges detonated by instantaneous electric blasting caps.



RESULT OF A BLAST: A series of small blasts, each consisting of only four holes, separated the floor from the roof slab. Shown here are large pieces of the floor, removed by previous blasts, hanging suspended in the mesh reinforcing.

NEWS NOTES

CONSTRUCTION EQUIPMENT CATALOG

The recent Construction Equipment Catalog, 600-9, is a 64-page publication covering the entire range of construction equipment manufactured by Chicago Pneumatic. It provides complete specification data on the company's line of air compressors, rock drill, pneumatic, and electric tools, and stationary engines. In addition, it offers information on the proper selection of air compressors as well as air-pressure and air-hose recommendations for practically every air-operated construction tool. For a copy, write to Department A-3, Chicago Pneumatic Tool Company, 6 East 44th Street, New York 17, New York.

CRAWLER PARTS BROCHURE

A four-page brochure illustrating the Tisco line of bulldozer sprocket rims, tractor pads, end bits, and blades is now offered by the Taylor-Wharton Company, division of Harsco Corporation. Operating advantages of Tisco renewable, work-hardening manganese steel parts are claimed by the company, and stock part specifications for all first-line crawlers are tabulated. The two-color brochure also describes procedures for rapid installation of Tisco sprocket rims. For your free copy, write Taylor-Wharton Company, High Bridge, New Jersey.

SKOOPER BULLETIN

The features of the Model 205 "Skooper," a full-revolving, crawler-mounted, front-end loader, are described in a new, two-color, eight-page bulletin now available from the Koehring Division of the Koehring Company, Milwaukee, Wisconsin.

The manufacturer states that the new front-end loader, available with a rehandling, rock, or general-purpose bucket, can load up to 400 tons an hour.

Illustrations and captions describe various mechanical features—independent traction, hydraulic crowd and dump assembly, standard cable hoist, etc.—and explain how the front-end loader's design cuts maintenance, operating costs, and operator fatigue. A series of on-the-job pictures show the machine at work in mining, excavating, stockpiling, and pavement-removing operations.

Copies are available from Koehring Division, Milwaukee 16, Wisconsin. Ask for bulletin K-636.

EXPLOSIONPROOF SWITCH DATA SHEET

A two-page data sheet describing the new "CX" series of raintight explosionproof switches is available from Micro Switch, Freeport, Illinois, a division of Minneapolis-Honeywell Regulator Company.

Designed for use on fuel- or chemical-handling devices, missile-launching equipment, and other hazardous outdoor installations, these switches are Underwriters' Laboratories-listed for use in Class I (vapor-air mixtures)—Groups C and D; Class II (dust-air mixtures)—Groups E, F, and G. Electrical capacity is 20 amps., 125, 250, or 460 vac.

Data sheet with photographs, dimension drawings, characteristics, mounting information, list prices, and quantity discounts can be obtained by writing to the manufacturer.

RESCUE EQUIPMENT BULLETIN

Complete details on M-S-A Porto-Power hydraulic rescue equipment are provided in a bulletin now available from Mine Safety Appliances Company, Pittsburgh.

The brochure describes operating principles of the equipment, which combines a hand-powered hydraulic pump and hydraulic ram to convert manual power into a maximum of 20 tons of power applied to rescue operations. A wide variety of applications is illustrated, including removal of piled debris, bracing of tunnel walls, opening smashed vehicle doors, and spreading jammed openings.

Three packaged Porto-Power sets are described in the bulletin: four-ton for light duty; 10-ton for general duty; and 10- and 20-ton for heavy duty. A special 50-ton unit for lifting in mine, railroad, factory, and marine disasters is also illustrated, together with a line of hydraulic hand jacks ranging from 1½ tons to 100 tons.

The bulletin is available on request from Mine Safety Appliances Company, 201 North Braddock Avenue, Pittsburgh 8, Pennsylvania.

NEWLY DESIGNED AIR COMPRESSOR

Gardner-Denver Company has introduced a new design of its 15-c.f.m. rotary portable air compressor.

According to company officials, the new design increases horsepower capacity 15%, for more fuel economy. Also, Gardner-Denver's "Thriftmeter Control" automatically regulates the engine speed to meet air demand, providing economical operation, longer engine and compressor life, and smooth operation.

The Model RP-125 introduced by Gardner-Denver features anti-blowback suction unloading valves and a larger toolbox that is both tamperproof and weatherproof. An automatic water-circulating system assures that the compressor and engine operate at a constant temperature, despite temperature changes.

More details of the Model RP-125 may be obtained by writing to Gardner-Denver Company, Quincy, Illinois.

TRUCK CRANE CATALOG

A new 16-page catalog describing the American 60-ton truck crane has been released by American Hoist & Derrick Company. Illustrations shown were actually taken on large engineering projects and big lifts. The catalog also describes and illustrates the many exclusive features claimed by the company on the 60-ton-capacity 700 series truck crane that will benefit both owner and operator.

Copies of the new catalog are available from the American Hoist distributors or direct from American Hoist & Derrick Company, St. Paul, Minnesota.

WELDING CATALOG

The Heliarc line of manual welding equipment is fully covered in a new 20-page catalog (F-8982E) now available from Linde Company, 30 East 42nd Street, New York 17, New York. Every manual torch in the Heliarc line is clearly illustrated in one-half actual size. Accessories available for each torch are described in the torch section of the catalog, and are also listed separately in handy table form. Complete ordering information is included. The Heliarc welding equipment described is suitable for manual welding of all commercial metals, ranging from thin-gage to ½-in. thick. Weldable metals include titanium, nickel, silicon-bronze, magnesium, aluminum, and galvanized steel.

TESTING OF SEALED AREAS OF COAL MINES

Development by Bureau of Mines' researchers of a new technique that can speed safe rehabilitation of coal-mine workings following fires was announced by the Department of the Interior.

The new method employs a series of diagrams that can be used to determine quickly whether an area which has been sealed in efforts to extinguish a coal-mine fire can be reopened safely. The atmosphere in such places frequently contains gas mixtures that are explosive or can become explosive when mixed with air. Hence, unsealing them may be hazardous.

A copy of Information Circular 7901, "Determining the Explosibility of Mine Atmospheres," can be obtained from the Bureau of Mines, Publications-Distribution Section, 4800 Forbes Avenue, Pittsburgh 13, Pennsylvania. Requests for this report should specify its number and title.

FLOODLIGHTING CATALOG

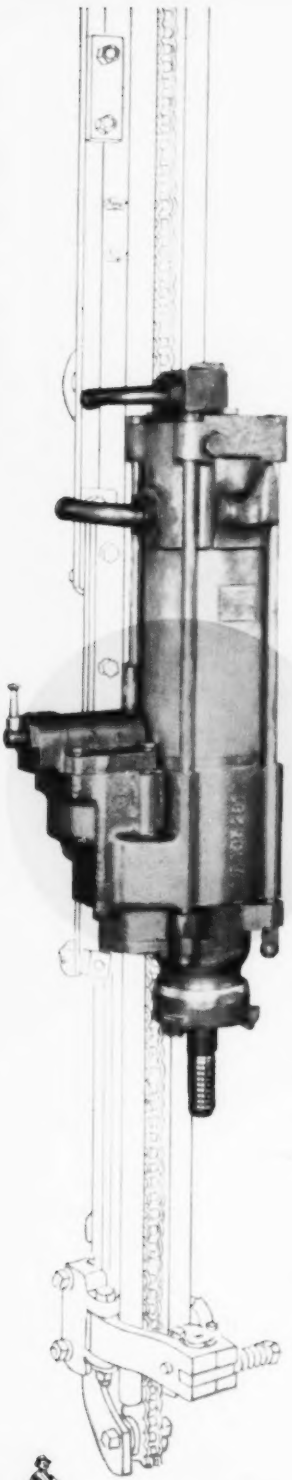
A handy catalog just issued by Stonco Electric Products Company, Kenilworth, New Jersey, condenses a good general cross section of its complete line of cast aluminum outdoor floodlights into eight pages. Included are illustrations, specifications, and dimensional drawings on new decorative outdoor bullets, medium and mogul base floodlights, high-intensity power beams, emergency portables, wiring troughs, splice boxes, and outdoor fittings, as well as cast aluminum pendant, ceiling, and wall fixtures for vaportight service. Write manufacturer for Catalog S.

SAFETY MANUAL

The National Safety Council has announced publication of the fourth edition of its "Accident Prevention Manual for Industrial Operations." The completely revised volume is described as "the most complete and informative safety reference work in existence."

A "summation of 46 years of safety experience," the manual was compiled, edited, and reviewed by safety specialists. It draws on the knowledge of safety men from nearly 7,000 firms spanning every U. S. industry. The publication contains more than 500 illustrations and 1,542 pages of up-to-the-minute data on every aspect of industrial safety.

Further information on the all-new edition of the Accident Prevention Manual may be obtained from the National Safety Council, 425 North Michigan Avenue, Chicago 11, Illinois.



The 450-DR is available on several self-propelled carriers, including the completely automatic TDM Trac-Drill shown at the right.

Another Joy First

The 450 DUAL Rotation Drill

- **25% Higher Drilling Speeds**
- **Faster Steel Changes**

In competitive demonstrations of 4½" bore drills, the new Joy 450-DR not only drilled faster, but also finished blastholes which the conventional reverse rotation machines could not bottom.*

Dual Rotation, which made this superior performance possible, is provided by a powerful vane-type air motor geared to the chuck. It provides a booster to normal drilling rotation, and gives extra rotation power while actually reducing the strain on the rifle bar.

Dual Rotation will also cut your costs because (1) there is no hammering action while coupling or uncoupling—drill steel threads, couplings and striking bars last longer; (2) all four pawls in the 450-DR are used only for forward rotation, not two for drilling and two for reversing—excessive pawl wear is eliminated; and (3) with Dual Rotation, reversing is not rifle bar actuated, therefore rifle nuts cannot back off—less downtime.

Let us prove the superiority of the new Joy 450-DR Drill. Your nearest Joy Office or Distributor will be glad to arrange a demonstration of this remarkable new drill.

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*Competitive test results available upon request.

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The New 30-R

has what it takes—and is ready to prove it

Check the specs . . . check the performance . . . you'll find the new Bucyrus-Erie 30-R offers the same outstanding stamina, speed, and ease of operation that make the 40-R and 50-R the most popular blast hole drills in their classes — *by far.*

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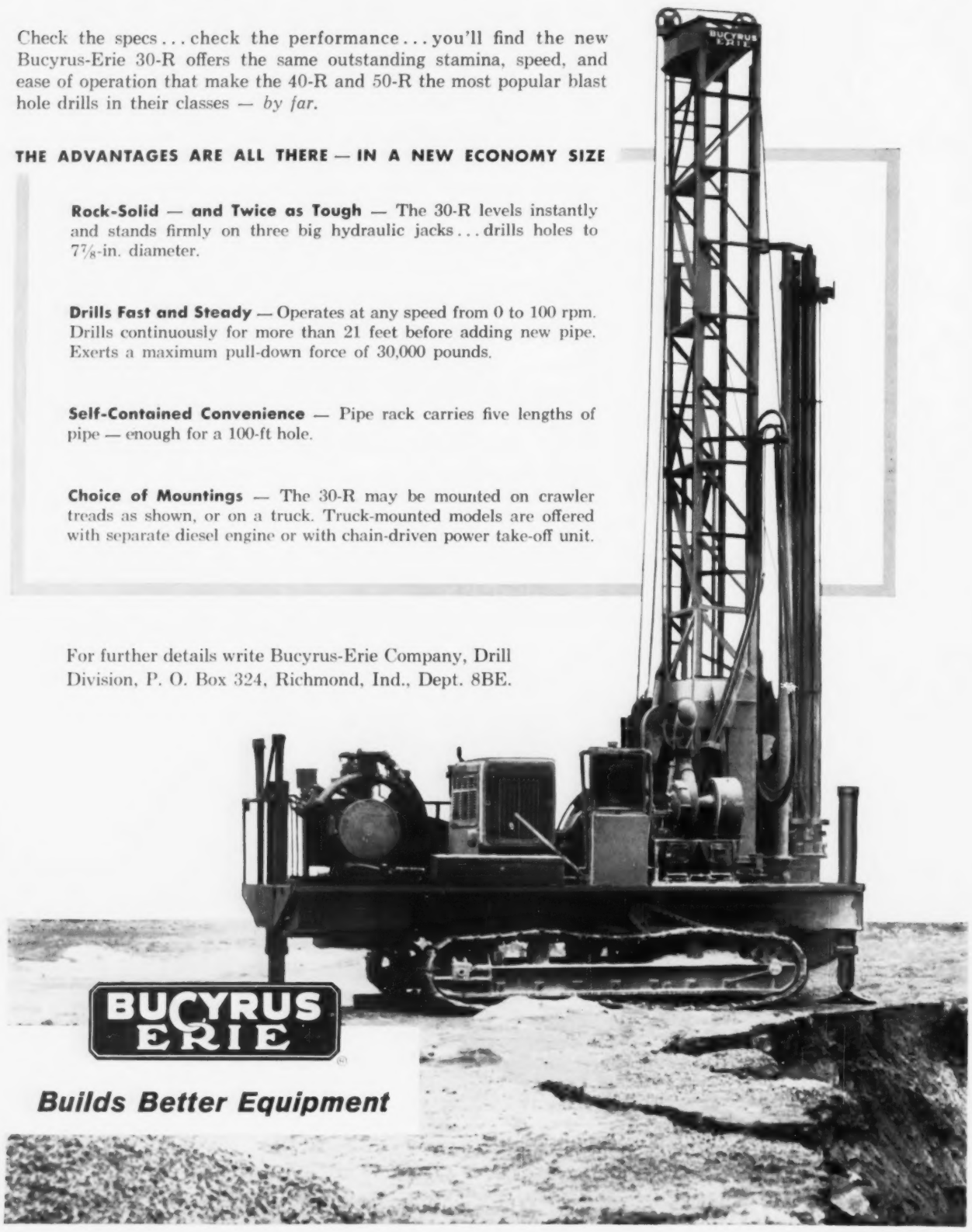
Rock-Solid — and Twice as Tough — The 30-R levels instantly and stands firmly on three big hydraulic jacks . . . drills holes to 7⅞-in. diameter.

Drills Fast and Steady — Operates at any speed from 0 to 100 rpm. Drills continuously for more than 21 feet before adding new pipe. Exerts a maximum pull-down force of 30,000 pounds.

Self-Contained Convenience — Pipe rack carries five lengths of pipe — enough for a 100-ft hole.

Choice of Mountings — The 30-R may be mounted on crawler treads as shown, or on a truck. Truck-mounted models are offered with separate diesel engine or with chain-driven power take-off unit.

For further details write Bucyrus-Erie Company, Drill Division, P. O. Box 324, Richmond, Ind., Dept. 8BE.



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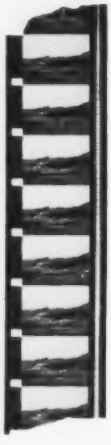
PRIMACORD® MS CONNECTORS*

are now available in three periods: 5, 9 and 17 MS

A Primacord MS Connector consists of a metal tube 2¾ inches long, containing an element that produces a delay measured in 5, 9 or 17 MS. A foot of Primacord is crimped in each end of the tube. The Primacord trunk line is cut between holes and the MS Connector joined to each of the two ends with a tight square knot, or lapped with pressure-sensitive tape. Packed 50 to a cardboard tube, 500 to a case.



16 mm movie film from which this enlargement was made.

This unretouched photograph was enlarged from a 16 mm frame. It shows a multiple hole blast detonated with Primacord, and hooked up with Primacord MS Connectors in the trunk line. Note the steady progress of this blast from the point of initiation at the left, as indicated by the red line.

Millisecond detonation of Primacord down lines in medium size holes offers many advantages in multiple hole blasting. Millisecond delay relieves burden, results in improved fragmentation. Less explosive may be required than for comparable instantaneous blasting. Decreased vibration and concussion, controlled throw and reduction of bootlegs are other advantages.

Under certain conditions the danger of cut-off holes can be minimized when Primacord MS Connectors are used on the order of 5, 9 or 17 milliseconds. In any event, the presence of unexploded powder in the muck is less hazardous when Primacord is the detonating agent. It cannot be set off by stray electrical currents, sparks, or ordinary shock, but must be detonated with fuse and cap or electric blasting cap.

For more information see your explosives supplier or write to

*Manufactured by E. I. duPont de Nemours & Company. Available through explosives suppliers

MS-1

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all-new 365-cfm GYRO-FLO

...a heavy-duty portable compressor with MORE POWER and MORE PERFORMANCE

Ingersoll-Rand, the pioneer builder of portable rotary compressors, now offers a completely new size Gyro-Flo portable—the DR-365. This rugged, all-new compressor provides 365 cfm of mobile air power—16% more than its predecessor, the Gyro-Flo 315. Yet, the DR-365 is no bigger than the 315 cfm Gyro-Flo, and its larger, more powerful engine retains the same 1800 RPM speed.

Take a closer look at what this all-new compressor offers: A new, simplified, more-efficient compressor system with...automatic drainage of oil from cylinders when the unit is shut down...dependable Air-Glide capacity control for 100% stepless regulation...a 12-volt battery system for faster, easier starting... side covers that fold back safely out of the way... a full-length, large capacity tool box to provide extra storage space...all operating controls, fuel tank, filters and tool storage enclosed by lockable side covers. These are just a few of the many features that mean more power, better performance, and greater convenience and safety, too.

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Ask your Ingersoll-Rand representative for complete information or send today for Bulletin 2932.

DIMENSIONS AND WEIGHTS	DR-365 with Diesel Engine
4-WHEEL MOUNTING	
Weight (dry)	5939
Weight (wet)	6640
Length (less drawbar)	10' x 5¾"
Width	5' x 8"
Height	6' x 10½"
Track	56
LESS RUNNING GEAR	
Weight (dry)	5279
Weight (wet)	5980
Length	10' x 2⅞"
Width	4' x 9½"
Height	5' x 2¾"

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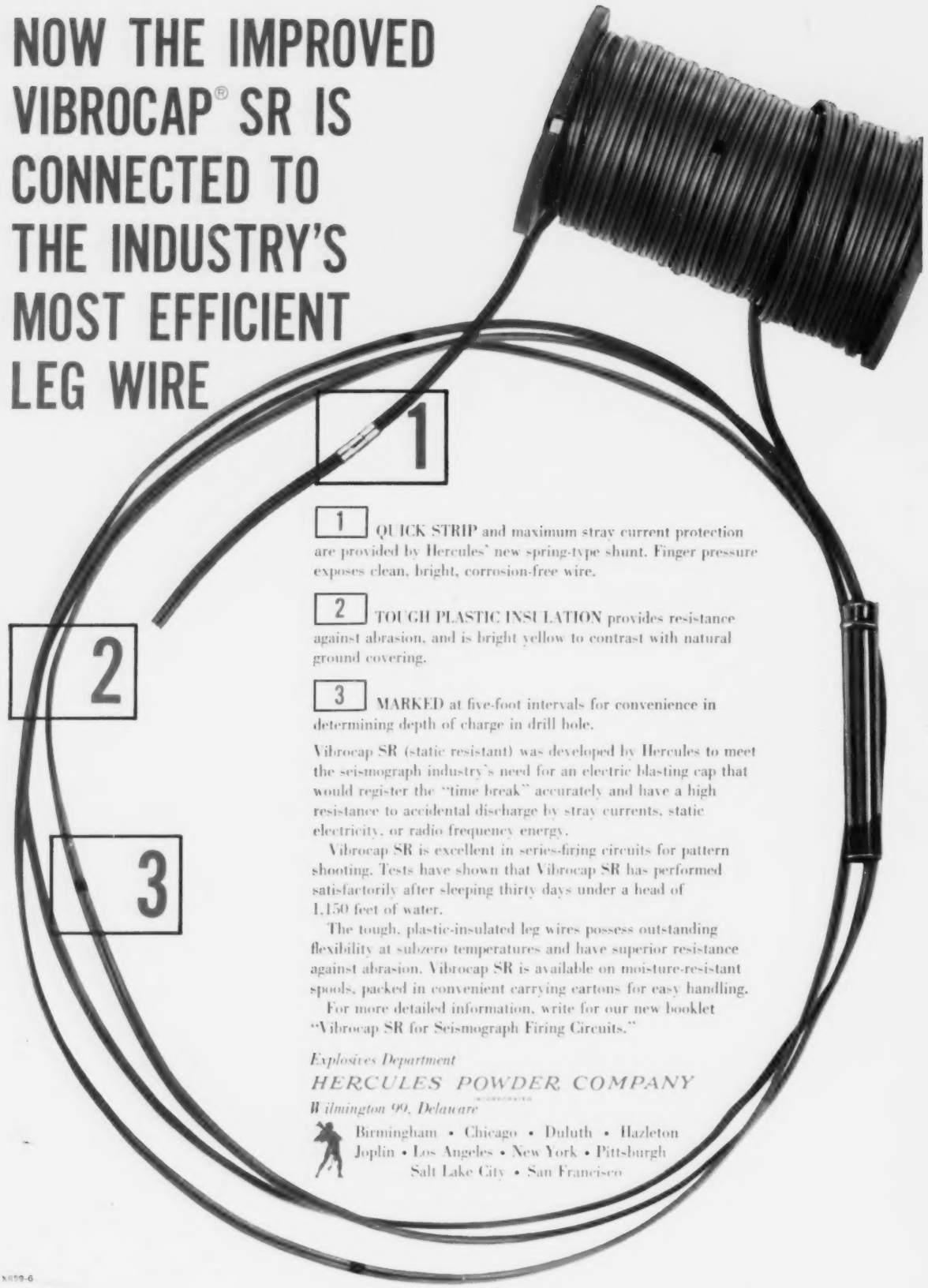

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